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QUALIFICATION TESTS OF THE HYDRAULIC ACTUATOR ASSEMBLIES DOUGLAS SCN'S 1A66248-503 AND -505

GENERAL TEST PLAN ITEM NO. M-4

MODEL NO. SATURN S-IVB

DOUGLAS REPORT SM-46580
AUGUST 1966

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AUGUST 1966

PREPARED BY:
SATURN STRUCTURAL/MECHANICAL DEPARTMENT

PREPARED FOR:
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SPACE ADMINISTRATION
UNDER NASA CONTRACT NAS7-101

APPROVED BY: A. P. O'NEAL
DIRECTOR, SATURN DEVELOPMENT ENGINEERING

DOUGLAS MISSILE & SPACE SYSTEMS DIVISION
SPACE SYSTEMS CENTER — HUNTINGTON BEACH, CALIFORNIA

ABSTRACT

This report describes the qualification tests conducted on the hydraulic actuator assemblies, Douglas SCN's (Specification Control Numbers) 1A66248-503 and -505, manufactured by Moog Servocontrols, Inc., East Aurora, New York, for use in the hydraulic system of the Saturn S-IVB stage.

The actuators were subjected to acceptance, vibration, mechanical shock, acceleration, life cycle, temperature environmental response, electromagnetic interference, thermal vacuum, heat-flow resistance, contamination, humidity, burst, and component valve tests. The results of the test program demonstrated that the hydraulic actuator assemblies, SCN's 1A66248-503 and -505, successfully met the test requirements and are qualified for use in the hydraulic system of the Saturn S-IVB stage.

DESCRIPTORS

Saturn S-IVB Stage

Hydraulic System Installation

Hydraulic Actuator Assembly

Prefiltration Valve

Cylinder Bypass Valve

PREFACE

The purpose of this memorandum is to describe the qualification test program conducted to determine the acceptability of the hydraulic actuator assemblies, Douglas SCN's 1A66248-503 and -505, for use in the hydraulic system of the Saturn S-IVB stage.

The test program was conducted by the Douglas Aircraft Company, Inc., in Santa Monica, California, and at the Douglas Space Systems Center at Huntington Beach, California, intermittently from November, 1964 to December, 1965.

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1. INTRODUCTION

1.1 Scope

This report describes the qualification tests performed by the Douglas Aircraft Company, Inc., on the hydraulic actuator assemblies, Douglas SCN's 1A66248-503 and -505; these assemblies are components of the Flight Control Hydraulic System of the Saturn S-IVB stage. The actuator, manufactured by Moog Servocontrols, Inc., East Aurora, New York, under model number 17-189, is procured by Douglas under Specification Control Drawing 1A66248.

Various operational and nonoperational environmental tests were performed to evaluate the operational performance and reliability characteristics required to qualify the actuators for use on the Saturn S-IVB stage. The test program was conducted intermittently from November 10, 1964, to December 12, 1965, at the Douglas engineering laboratories in Santa Monica, California, and at the Douglas Space Systems Center in Huntington Beach, California. The test parts and equipment used during the testing are listed in Appendix 1 of this report. Appendices 2, 3, and 4 contain figures, charts, and tables, supplementing the information given in the main body of the document.

1.2 Description

The actuator assemblies, SCN's 1A66248-503 and -505, are linear double-acting equal-area electro-hydraulic cylinders incorporating mechanical piston position feedback. See figures 1 and 1a. The wet weight of each of the assemblies is 41

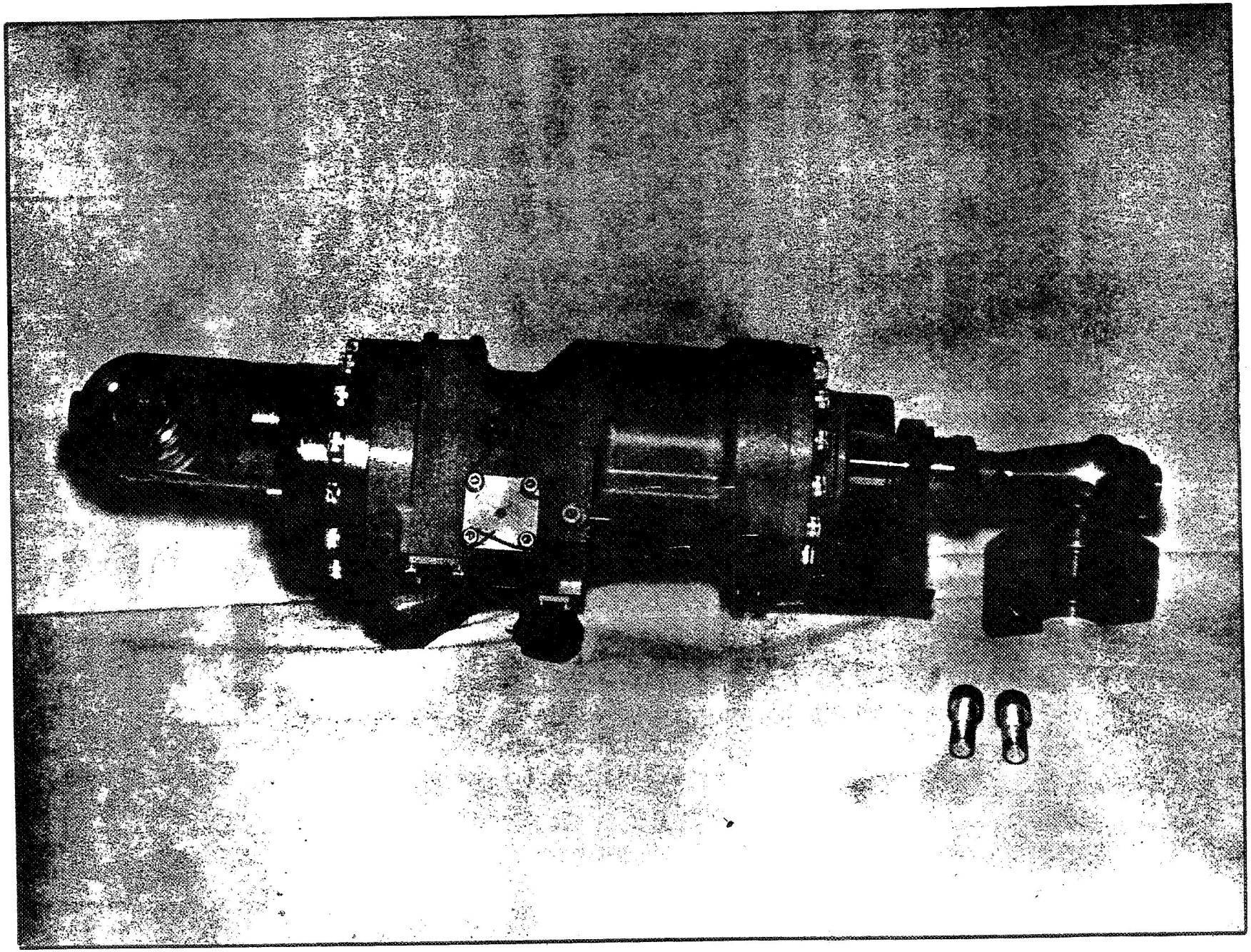


Figure 1. Hydraulic Actuator Assembly, SCN 1A66248-503

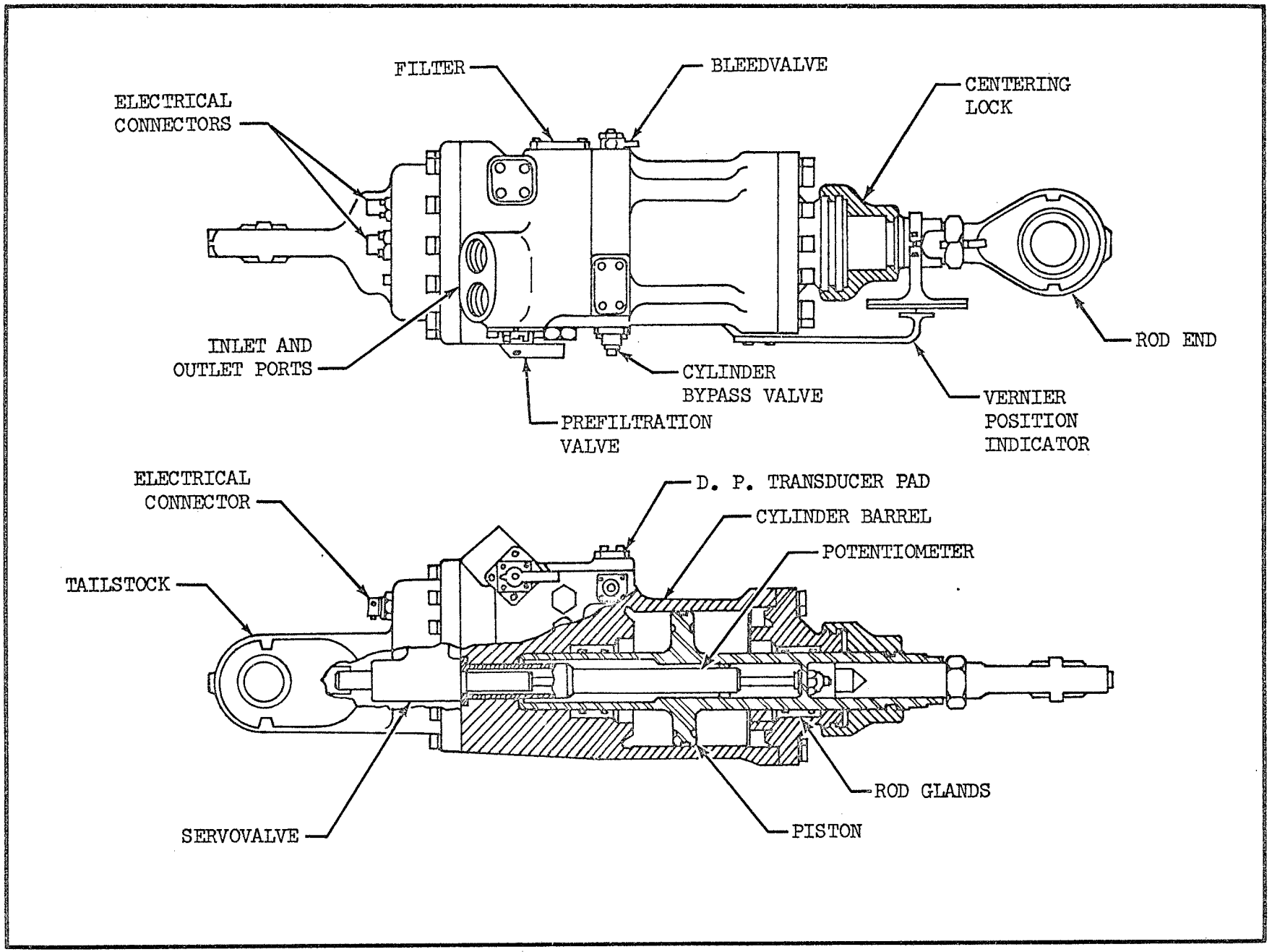


Figure 1a. Cutaway View of Hydraulic Actuator Assembly

1.2 (Continued)

pounds. The normal hydraulic supply and return pressures are 3,650 and 150 psig, respectively. The effective area of the actuator piston is 11.78 square inches, with a stroke from neutral of ±1.45 inches. The center-to-center distance between the attach points is 23.0 inches with the piston in neutral position.

The actuator body, machined from a 2014-T6 aluminum-alloy forging, is approximately 6 1/2 inches in diameter. The aluminum body provides lightweight construction and good heat-transfer characteristics. The actuator tailstock is machined from a 6AL-4V titanium-alloy forging, and the rod end is fabricated from 6AL-4V titanium. Titanium offers a high-strength to low-weight ratio and good thermal isolation characteristics. The latter feature is desirable because of the need for a high actuator body temperature in relation to the low temperatures of the thrust structure and engine surface.

In addition to the standard servoactuator components, namely the electrohydraulic servovalve, mechanical feedback, and the piston position-indicating potentiometer, the actuator body contains several cartridge-mounted components as shown in figure 2. These include a DP-F (derivative-pressure feedback) network, a prefiltration valve, a cylinder bypass valve, and a hydraulic fluid filter. Individual photographs of most of the actuator components are presented in Appendix 2, figures 2-1 through 2-5. The actuator package also includes a differential-pressure transducer and a temperature probe, which are installed on the actuator body. These instruments measure cylinder hydraulic differential-pressure and cylinder hydraulic fluid temperature during flight. Figure 2-14 in Appendix 2 is a diagram showing the relationship of the actuator components.

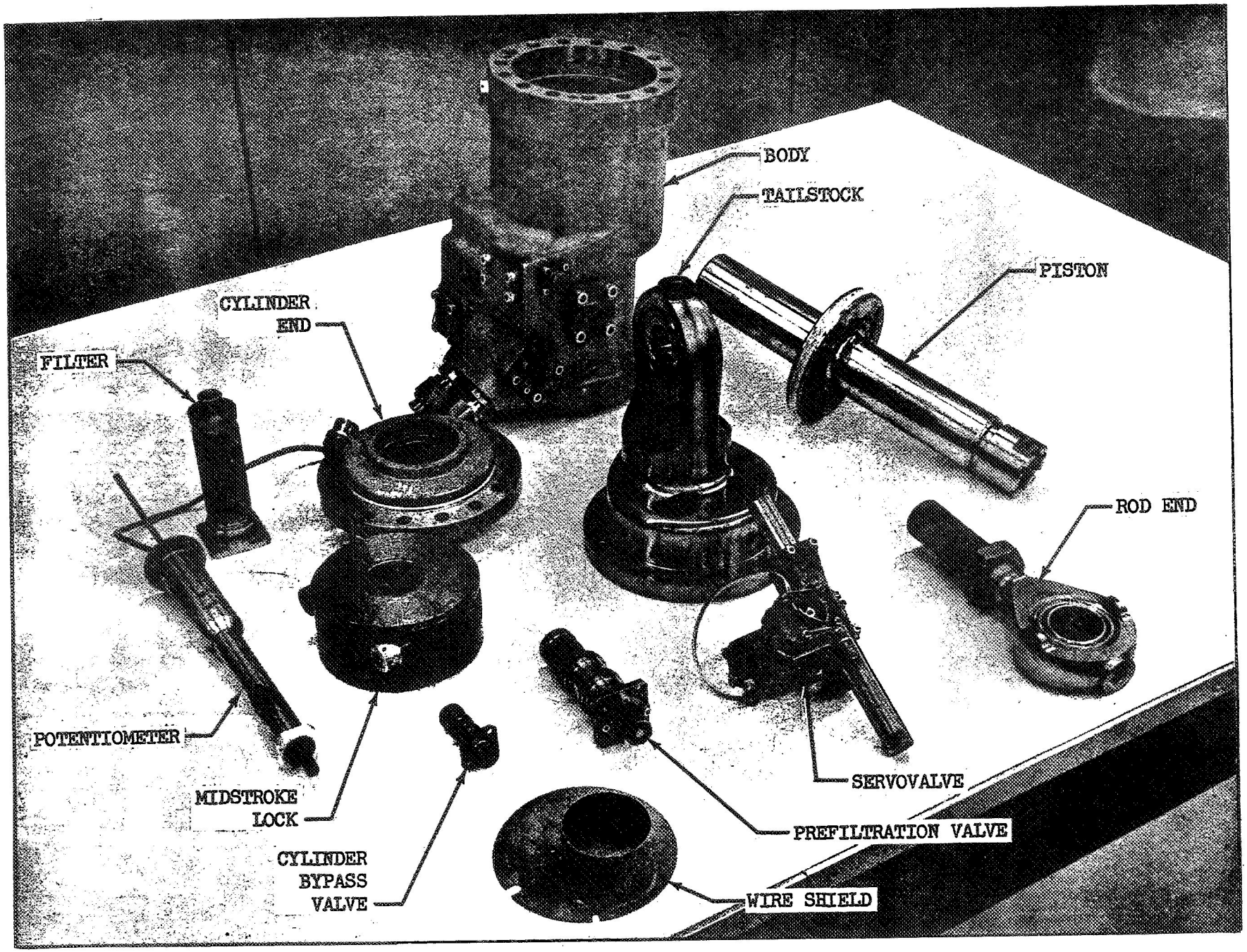


Figure 2. Disassembled Hydraulic Actuator

1.3 Function

Two actuators, located 90 degrees apart with respect to the longitudinal axis of the S-IVB stage, provide engine thrust-vector position control, and thus vehicle directional control, in the pitch and yaw planes. Thrust-vector positioning commands from the vehicle guidance computer are electromagnetically transformed into torque at the servovalve armature. Responding to torque, the armature-flapper assembly in turn controls the servovalve first-stage hydraulic bridge, producing the second-stage flow-spool positioning forces. With the 4-way flow-spool commanded off-center, high-pressure hydraulic fluid is ported to the actuator cylinders, thus moving the engine.

Positive control of engine position is determined by a mechanical feedback mechanism consisting of a cam, follower, spring, and linkage between the actuator piston and the servovalve armature. As the actuator is moving to a new engine position commanded by the guidance computer, the mechanical feedback mechanism applies a torque in the opposite direction from the command torque, to return the armature and flow-spool to the neutral position. Flow-spool position is controlled by a feedback wire located between the flow-spool and the flapper portion of the armature.

Artificial damping of system load resonance is provided by a dynamic pressure feedback system. The mechanism to achieve this is incorporated into the actuator envelope. The DP-F network form of dynamic compensation uses a piston and springs to sense the high-piston differential

pressures at resonance. Proportional flow forces, opposing the command signal, are then transmitted to the flapper, this in effect reducing the command signal. This system is inoperative at low frequencies.

The cylinder bypass valve is a push-to-operate valve which connects the two cylinder chambers to allow manual movement of the actuator piston. When in the bypass position, the prefiltration valve routes hydraulic fluid directly from supply to return through the actuator filter.

1.4 Test Plan

The following table represents TPI (test plan item) M-4 from Douglas Report SM-41412. This TPI covers the qualification tests of the hydraulic actuators, SCN's 1A66248-503 and -505. Initially, five actuator assemblies had been allocated for the qualification test program; however, two test specimens, numbers 1 and 5, were deleted per General Test Plan Change Request No. 040. Specimen numbers 1 and 5 were deleted because it was felt that the objectives of the test program could be satisfied with only three specimens. The remaining test specimens were designated specimen numbers 2, 3, and 4, corresponding to Moog Servocontrols, Inc., serial numbers 8, 9, and 10, respectively.

The numbers in the table indicate the actual sequence of testing of the test specimens. Items which required special handling during the test program are designated alphabetically in the remarks column, corresponding to explanations in the text immediately following the TPI.

	6	4	3	2		TEST SPECIMEN NO.						
						COMPONENT SPECIMEN NO.						
	A	B	C	D		TEST SPECIMEN SERIAL NUMBER						
						AS-R'CD CLEANLINESS AND PROOF PRESS.	ACCEPTANCE TESTS					
						ELECT. AND MECH CENTERING						
						LENGTH, ADJ. AND STROKE						
						F.B.POT.CONTINUITY,LIN & TRAVEL						
						COIL RESISTANCE						
						DIELECTRIC BREAKDOWN						
						POT. RESISTANCE						
						SERVOVALVE POLARITY						
	2	2		2		FLOW						
	1	1		1		INTERNAL LEAKAGE						
						STATIC SEAL LEAKAGE						
						PIST.ROD END DYN.SEAL LEAKAGE						
						PISTON PACKING FRICTION						
						ACTUATOR GAIN						
						FLOW GAIN						
						FREQUENCY RESPONSE						
						LOW-TEMP. FREQ. RESP.	OPERATIONAL TESTS					
						HIGH-TEMP. FREQ. RESP.						
						VIBRATION - ROOM TEMP.						
						VIBRATION - HIGH TEMP.						
						ACCELERATION						
						MECHANICAL SHOCK						
						THERMAL VACUUM						
						RESIS. TO HEAT FLOW						
						ELECTROMAG. INTERFERENCE						
	1					LIFE CYCLE AND AXIAL LOAD						
						CONTAMINATION						
		X	X			PREFILTRATION VALVE						
			X	X		CYLINDER BYPASS VALVE						
						HUMIDITY - HIGH TEMP.	NON-OPER.					
						BURST - HIGH TEMP.						
						REMARKS						

1.4 (Continued)

a. The electrical connector on test specimen No. 2 malfunctioned during the room-temperature vibration test. The test specimen was returned to the vendor for analysis and refurbishment.

b. Contamination data, other than as-received cleanliness, was not obtained from test specimen No. 2.

c. Because the electrical connector failed on test specimen No. 2, testing was stopped on test specimens No. 3 and 4. All three test specimens were returned to the vendor for connector rework and other vendor improvements. The following changes, made on the 1A66248 actuator by the vendor, resulted in changing the Douglas configuration number from -501 to -503.

   (1) The valve and potentiometer electrical connectors were electron-beam welded to the adapter, in place of soldering.

   (2) The servovalve amplifier and DP-F nozzles were removed and replaced with nozzles having bumpers. During the vendor's development test, sharp edges of the nozzles were marking the flapper.

   (3) The piston-cap seal was replaced with a cap having deeper sides with side notches. This improvement was required on the S-II actuator when a blow-by failure of the seal was experienced. The improved seal was then incorporated on the S-IVB actuator.

1.4 (Continued)

d. A contamination study performed on test specimens No. 3 and 4 during the temperature environmental response tests provided adequate statistical contamination information on the actuator.

e. Test specimen No. 2 was to have been tested under high-temperature loaded vibration. However, during the previbration checkout under high-temperature conditions, in which the actuator may have seen temperatures as high as +325°F, the actuator stopped operating. Three servovalve coil wires had become disconnected from the electrical connector. Apparently, the high temperature (the solder in the pin cavities appeared to have flowed) and possible tension load on the wires (potting was poor and coil wires were not held fast) caused the malfunction. Specimen No. 2 was sent to the vendor for analysis and refurbishment.

f. Test specimen No. 3 was substituted for No. 2 and completed the high-temperature loaded vibration test successfully. However, the post-vibration frequency response revealed a high-amplitude peaking on the load position/current response. This indicated a reduction in damping, possibly within the DP-F network. Test specimen No. 3 was returned to the vendor for analysis and refurbishment.

g. The titanium tailstock of test specimen No. 4 cracked during the life cycle testing. This failure resulted in the W change to Specification Control Drawing 1A66248, approving the vendor's request to strengthen the tailstock.

2. TESTS

2.1 Acceptance Test Requirements and Procedures

Acceptance tests were conducted on test specimens No. 2, 3, and 4 in accordance with paragraphs 2.1.1 through 2.1.17.2 Sufficient procedural information is included to explain the manner in which the tests were performed. The test results are given in paragraph 2.1.18 and the accompanying tables.

2.1.1 As-Received Cleanliness

2.1.1.1 Requirement

Hydraulic-fluid samples drawn from the supply and return lines of the as-received actuator shall satisfy the following particle limitations, based on the NASA cleanliness specification, MSFC-PROC-166A.

2.1.1.1 (Continued)

Size (Micron)	Number of Particles	
	Return	Supply
10 to 25	2,150	1,340
26 to 50	530	210
51 to 100	60	28
101+	10	3

2.1.1.2 Procedure

With the midstroke mechanical lock removed and the prefiltration valve in the bypass position, hydraulic fluid was circulated through the actuator for 10 minutes. Following this 10-minute purge, the prefiltration valve was placed in the open position and the actuator hydraulic supply pressure was raised to 1,200 psig. The actuator piston was allowed to cycle three times, after which the supply-line sampling valve was opened. Approximately 300 ml of hydraulic fluid was drained off, followed by the next 100 ml of hydraulic fluid which was retained in a sample bottle for particle analysis. This sampling procedure was immediately repeated for the return-line sample.

2.1.2 Proof Pressure

2.1.2.1 Requirement

The actuator shall withstand 5,500-psig hydraulic supply and 375-psig hydraulic return pressures without failure, permanent deformation, or external leakage.

2.1.2.2 Procedure

Hydraulic supply pressure of 5,500 psig was applied to the actuator for 3 minutes with the piston commanded hardover extend and for 3 minutes with the piston commanded hardover retract. In each of the preceding instances, hydraulic return pressure was maintained at 375 psig.

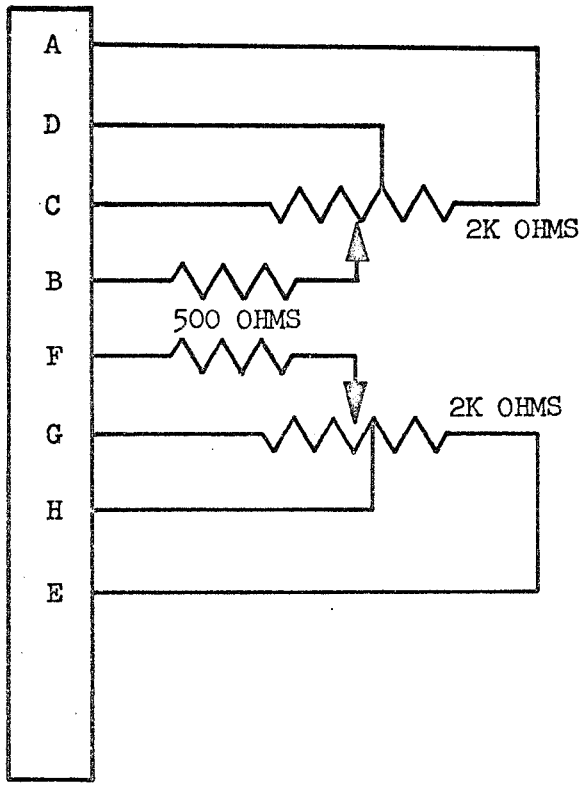
2.1.3 Electrical and Mechanical Centering

2.1.3.1 Requirement

With the midstroke mechanical lock installed, and with from +24-vdc to +28-vdc excitation voltage applied to the piston-feedback potentiometer elements, the output measured at pins B and D shall be ±0.001325 (excitation voltage), and at pins F and H shall be ±0.006325 (excitation voltage). With the midstroke mechanical lock removed, with 3,650-psig hydraulic supply pressure applied to the actuator, and with from +24-vdc to +28-vdc excitation voltage applied to the potentiometer elements, the output measured at pins B, D, F, and H shall be ±0.00985 (excitation voltage). Figure 3 is the electrical schematic of the potentiometer.

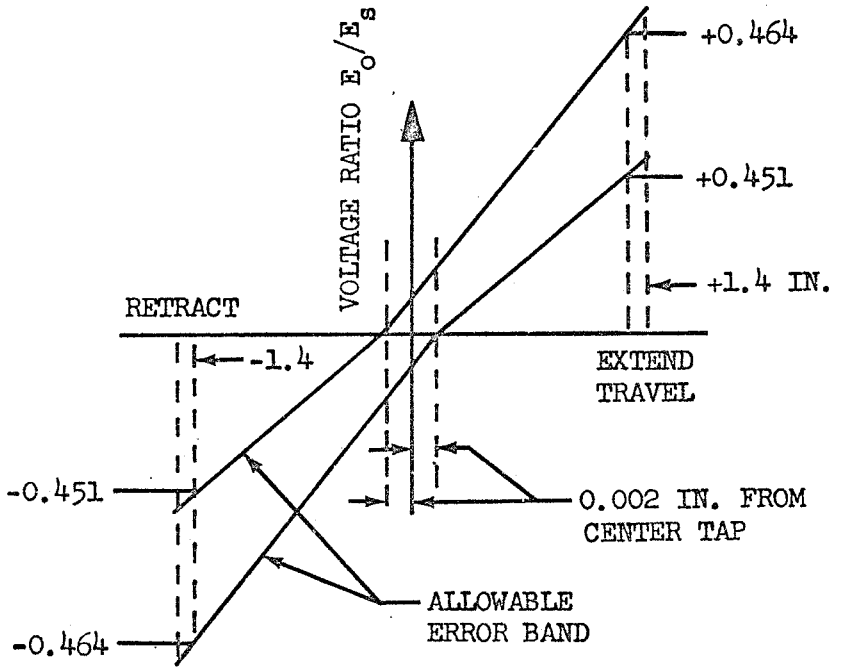
2.1.3.2 Procedure

With the midstroke mechanical lock installed, +24 vdc was applied to the two piston feedback potentiometer elements. Voltages at pins B and D and pins F and H were measured with a dc voltmeter, representing the difference between potentiometer electrical center and the mechanical center for the two piston potentiometer elements. The midstroke mechanical lock was then removed and 3,650-psig hydraulic supply pressure was applied to



E_o = FEEDBACK OUTPUT VOLTAGE, PINS B&D AND PINS F&H

E_s = EXCITATION VOLTAGE, PINS A&C AND PINS G&E



VOLTAGE OUTPUT CURVE

Figure 3. Feedback Potentiometer, Electrical Schematic

2.1.3.2 (Continued)

the actuator. Voltages at pins B and D and pins F and H were again measured with the dc voltmeter. These voltages represent the difference between the potentiometer electrical center and the piston hydromechanical free position.

2.1.4 Length, Adjustment, and Stroke

2.1.4.1 Requirement

Actuator attachment center-to-center length shall be 23.00±0.63 inches. Actuator stroke shall be ±(1.45±0.030) inches from center.

2.1.4.2 Procedure

Length, adjustment, and stroke were determined by installing the test specimens in the acceptance test holding fixture and measuring with the dial indicator.

2.1.5 Feedback Potentiometer Continuity, Linearity, and Travel

2.1.5.1 Requirement

Potentiometer output voltage ratios shall conform to the limits provided in figure 3 for ±1.4-inch extend and retract actuator piston positions.

2.1.5.2 Procedure

The feedback potentiometer leads were attached to an oscilloscope and the output signal observed for flat spots or lack of continuity during actuator piston full-stroke excursion. Potentiometer output ratio was obtained by measuring wiper voltages at the extend and retract actuator-piston positions. The potentiometer test set and a dial indicator were attached to the potentiometer. With the actuator piston in center, the dial indicator was set to zero and the voltage output ratio was measured. This output ratio was summed with the extend and retract readings to give the correct ratios at these points. Potentiometer voltage ratios were obtained for ±1.4-inch extend and retract actuator piston positions.

2.1.6 Coil Resistance

2.1.6.1 Requirement

Dc resistance between pins A and B of the servovalve coil shall be 100±5 ohms at 100°F temperature.

2.1.6.2 Procedure

Resistance across servovalve coil pins A and B was measured with a resistance bridge for 100°F coil temperature in room-temperature environment.

2.1.7 Dielectric Breakdown

2.1.7.1 Requirement

Servovalve pin-to-case resistance shall not change following the application of 1,000 vdc for 60 seconds between servovalve pin A and the case and between pin B and the case.

2.1.7.2 Procedure

A voltage of 1,000 vdc was applied for 60 seconds between servovalve pin A and the case and then between pin B and the case, using the insulation breakdown tester.

2.1.8 Potentiometer Resistance

2.1.8.1 Requirement

Resistance of the two piston potentiometer elements when measured at pins A and C and pins G and E shall each be 2,000±200 ohms at 77°F temperature. Wiper contact resistance when measured between pins B and D and pins F and H shall each be between 450 ohms minimum and 700 ohms maximum.

2.1.8.2 Procedure

A resistance bridge was used to measure potentiometer element resistances across pins A and C and pins G and E and to measure contact resistances between pins B and D and pins F and H at room-temperature conditions.

2.1.9 Servovalve Polarity

2.1.9.1 Requirement

With servovalve pins A and B biased positive to negative, the actuator piston shall retract. With servovalve pins A and B biased negative to positive, the actuator piston shall extend.

2.1.9.2 Procedure

Hydraulic pressure of 500 psig was applied to the actuator. A 6-volt battery was used to apply the piston extend signal with servovalve pin B positive and pin A negative. The battery leads were reversed, B negative and A positive, to retract the actuator.

2.1.10 Flow

2.1.10.1 Requirement

With 3,650-psig hydraulic supply pressure, actuator flow shall be 10.5±1.5 gpm at 100°F temperature.

2.1.10.2 Procedure

With the actuator supply and return lines attached to hydraulic system No. 9, 3,650-psig hydraulic supply pressure was applied to the actuator. An actuator sinusoidal cycling command of full stroke at 0.3 cps was applied to the actuator. Actuator flow at 100°F from a 2- to 20-gpm turbine-type flowmeter was monitored with an oscillograph.

2.1.11 Internal Leakage

2.1.11.1 Requirement

With 3,650-psig hydraulic supply pressure, internal leakage shall be 0.2-gpm minimum to 0.4-gpm maximum at 100°F temperature.

2.1.11.2 Procedure

With 3,650-psig hydraulic supply pressure at 100°F applied to the actuator and no command signal, actuator return flow was measured with a 0.15- to 1.5-gpm turbine-type flowmeter.

2.1.12 Static Seal Leakage

2.1.12.1 Requirement

With hydraulic pressure maintained at 6 to 10 psig for 15 minutes at the actuator supply and return ports, there shall be no external leakage.

2.1.12.2 Procedure

With the midstroke mechanical lock installed, a 30-psig pressure gage was installed in the hydraulic-system return line. Hydraulic pressure of 6 to 10 psig was applied to the actuator supply and return ports, and the cylinder bypass valve was held open. Hand valves in the supply and return lines were closed to lock in the pressure for a period of 15 minutes. Pressure decay and external leakage were monitored.

2.1.13 Piston Rod-End Dynamic-Seal Leakage

2.1.13.1 Requirement

With 3,650-psig supply pressure applied, the actuator shall be cycled full-stroke 50 times. Rod-end leakage shall not exceed 4 drops of oil over this interval.

2.1.13.2 Procedure

With the midstroke mechanical lock removed and the cylinder bypass valve closed, 3,650-psig hydraulic supply pressure was applied to the actuator. The piston was cycled full-stroke 50 times and rod-end leakage was monitored.

2.1.14 Piston Packing Friction

2.1.14.1 Requirement

With 500-psig hydraulic supply pressure, the differential pressure required to move the unloaded actuator piston shall not exceed 100 psid.

2.1.14.2 Procedure

A 0- to 500-psid differential-pressure transducer was connected to the actuator cylinder chambers and the transducer monitored with an oscillograph. Hydraulic supply pressure of 500 psig was applied to the actuator. Step commands resulting in ±1-inch piston stroke were applied to the actuator. Cylinder differential pressures were obtained with the oscillograph.

2.1.15 Actuator Gain

2.1.15.1 Requirement

Static unloaded piston to current gain of the actuator shall be 0.031±0.0061 inch per ma.

2.1.15.2 Procedure

Pins B and D of the piston position potentiometer were attached to the input terminals of an X-Y plotter along with the current input signal. Hydraulic supply pressure of 3,650 psig was applied to the actuator. A manual command signal to move the actuator piston from null to +6 ma to -6 ma to null was applied to the actuator. The slope of the line drawn through the center of the hysteresis loop was the actuator gain.

2.1.16 Flow Gain

2.1.16.1 Requirement

Servovalve flow gain shall be 5.25 cis per ma (±10 per cent) with the hydraulic supply at 3,500 psig pressure and 100°F temperature.

2.1.16.2 Procedure

An adapter block was installed in place of the cover plate over the actuator cylinder ports, and the midstroke mechanical lock was installed. Flow from the adapter block was ported to the flow measuring device of hydraulic system No. 9. Flow and valve-current signals were supplied to the drum-type X-Y plotter. Hydraulic supply pressure of 3,500 psig at 100°F was applied to the actuator. Current commands to ±7 ma around the hysteresis loop were applied to the actuator. The slope of the plotted curve was taken as the servovalve flow gain.

2.1.17 Frequency Response

2.1.17.1 Requirement

With the actuator installed in a test fixture simulating rocket-engine inertia and structural compliance, the closed-loop frequency-response load position/command current for the ±0.5-degree amplitude signal shall conform to the following limits. The maximum normalized load position/command amplitude ratio for all frequencies shall be less than ±3.5 db. The load position/command current phase angle shall be less than 35 degrees at 1.0 cps.

2.1.17.2 Procedure

The actuator was mounted on the load simulator and 3,650-psig hydraulic pressure applied. The frequency response test was performed automatically by the RW-300 computer system. Driving signals from the computer cycled the actuator while other computer monitoring channels measured signals at desired locations in the servoloop. The data was instantaneously reduced to the desired form of tables and plots of servo transfer functions.

2.1.18 Acceptance Test Results

Acceptance test results for specimens No. 2, 3, and 4 are presented in Tables 1, 2, and 3 respectively. As the data indicates, the acceptance test requirements were satisfied by all of the test specimens. Acceptance test frequency response data may be found in Appendix 3, charts 3-1 through 3-6 and Appendix 4, Tables 4-1 through 4-3.

TABLE 1. ACTUATOR ACCEPTANCE TEST RECORD, TEST SPECIMEN NO. 2

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1	Inspection	See Spec. 1A88230	Inspected
2.1.1	As-Received Cleanliness (Particles)	Size (Microns) / Number Return / Supply 10-25: 2,150 / 1,340 26-50: 530 / 210 51-100: 60 / 28 101+: 10 / 3	*See note below. Return / Supply 680 / 960 760 / 570 25 / 18 13 / 25
2.1.2	Proof Pressure	No Damage No External Leakage	No Damage No External Leakage
2.1.3	Electrical and Mechanical Centering	±0.001325 (+24 v excitation at zero psig) ±0.006325 (+24 v excitation at 3,650 psig) Allowable: ±31.7 mv B & D ±152 mv F & H	Pins / Zero Psig / 3,650 Psig B & D: +4.3 mv / -70 mv F & H: +4 mv / -70 mv
2.1.4	Length, Adjustment, and Stroke	Actuator Centered 23.00±0.063 Actuator Retracted -1.45±0.030 Total Piston Stroke +2.90±0.032	Actuator Centered +0.002 Actuator Retracted -1.441 Total Piston Stroke +2.882
2.1.5	Feedback Potentiometer Continuity, Linearity, and Travel	See figure 3.	Extend: ABCD = 0.458 EFGH = 0.459 Retract: ABCD = 0.456 EFGH = 0.455
2.1.6	Coil Resistance	100±5 ohms at 100°F	99 ohms
2.1.7	Dielectric Breakdown	No breakdown at 1,000 vdc for 60 seconds	No breakdown

NOTE: THE PARTICLE COUNTS EXCEEDED THE ALLOWABLE VALUES. A SOMEWHAT RELAXED ATTITUDE REGARDING PARTICLE CONTAMINATION EXISTED THROUGHOUT THE TESTING. FOR PURPOSES OF EXPEDIENCY, IT WAS DECIDED TO RELAX THE VIGOROUS CONTROL OF PARTICLE SIZE AND QUANTITY CUSTOMARILY REQUIRED OF PRODUCTION COMPONENTS. PAST EXPERIENCE HAD PRODUCED A HIGH LEVEL OF CONFIDENCE IN LABORATORY TEST-STAND CLEANLINESS, WITH THE RESULT THAT PERIODIC SAMPLING AND CONTAMINANT COUNTING WAS CONSIDERED SUFFICIENT. IN THIS CASE, THE TESTS WERE PERFORMED WITHOUT A CURRENT PARTICLE ANALYSIS. WHEN CONDUCTED, THE ANALYSIS WAS OUT OF PRODUCTION TOLERANCE, AS INDICATED. HOWEVER, THE SIZE AND QUANTITY OF PARTICLES OUT OF TOLERANCE WERE NOT CONSIDERED EXCESSIVE FOR THE S-IVB ACTUATOR AND A TYPICAL LABORATORY SYSTEM.

TABLE 1. ACTUATOR ACCEPTANCE TEST RECORD, TEST SPECIMEN NO. 2 (Continued)

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1.8	Potentiometer Resistance	Pins Ohms A & C 2,000±200 G & E 2,000±200 B & D 450 min., 700 max. F & H 450 min., 700 max.	Ohms 2,025 2,049 556 534
2.1.9	Servovalve Polarity	A+, B- Retract B+, A- Extend	A+, B- : Retracted B+, A- : Extended
2.1.10	Flow	10.5±1.5 gpm at 100°F	Acceptable
2.1.11	Internal Leakage	0.2 gpm min. 0.4 gpm max.	0.24 gpm
2.1.12	Static Seal Leakage	No external leakage	None
2.1.13	Piston Rod End Dynamic Seal Leakage	4 drops max.	None
2.1.14	Piston Packing Friction	100 psid	18.75 psid
2.1.15	Actuator Gain	0.031±0.0016 in./ma (0.0294 min.)	Run 1 Extend: 0.0286 Retract: 0.0288 Run 2 (accurate plot) Extend: 0.0311 Retract: 0.0311
2.1.16	Flow Gain	5.25 cis/ma ±10% (from 1.227 to 1.499 gpm per ma at 100°F)	1.37 gpm/ma
2.1.17	Frequency Response	Max. Amplitude Ratio: 5 db Max. Phase Lag: 35° at 1 cps	Max. Amplitude Ratio: 4.5 db Max. Phase Lag: 22° at 1 cps

TABLE 2. ACTUATOR ACCEPTANCE TEST RECORD,
TEST SPECIMEN NO. 3 (CONTINUED)

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1.7	Dielectric Breakdown	No breakdown at 1,000 vdc for 60 seconds.	No breakdown
2.1.8	Potentiometer Resistance	Pins Ohms A & C 2,000±200 G & E 2,000±200 B & D 450 min., 700 max. F & H 450 min., 700 max.	Ohms 1,875 1,978 621 607
2.1.9	Servovalve Polarity	A+, B- : Retract B+, A- : Extend	A+, B- : Retracted B+, A- : Extended
2.1.10	Flow	10.5±1.5 gpm at 100°F	10.3 gpm
2.1.11	Internal Leakage	0.2 gpm min. 0.4 gpm max.	0.33 gpm
2.1.12	Static Seal Leakage	No external leakage	None
2.1.13	Piston Rod End Dynamic Seal Leakage	4 drops max.	Acceptable
2.1.14	Piston Packing Friction	100 psid	12.5 psid
2.1.15	Actuator Gain	0.031±0.0016 in./ma	0.0312 in./ma
2.1.16	Flow Gain	5.25 cis/ma ±10% (from 1.227 to 1.499 gpm per ma at 100°F)	1.33 gpm/ma
2.1.17	Frequency Response	Max. Amplitude Ratio: 5 db Max. Phase Lag: 35° at 1 cps	Plotted: see charts 3-3 and 3-4

TABLE 3. ACTUATOR ACCEPTANCE TEST RECORD, TEST SPECIMEN NO. 4

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1	Inspection	See Spec. 1A88230	Inspected
2.1.1	As-Received Cleanliness (Particles)	Size (Microns) / Number Return / Number Supply: 10-25: 2,150 / 1,340 26-50: 530 / 210 51-100: 60 / 28 101+: 10 / 3	Return / Supply: 2,290 / 2,480 560 / 760 61 / 81 21 / 13
2.1.2	Proof Pressure	No Damage No External Leakage	No Damage No External Leakage
2.1.3	Electrical and Mechanical Centering	±0.001325 (+24 v excitation at zero psig) ±0.006325 (+24 v excitation at 3,650 psig) Allowable: ±31.7 mv B&D ±152 mv F&H	Pins / Zero Psig / 3,650 Psig: B & D: +0.0009 in. / +0.007 in. B & D: +7.6 mv / +5.7 mv F & H: +0.0033 in. / +0.0095 in. F & H: +26 mv / +75 mv
2.1.4	Length, Adjustment, and Stroke	Actuator Centered 23.00±0.063 Actuator Retracted -1.45±0.030 Total Piston Stroke +2.90±0.032	Actuator Centered +0.027 Actuator Retracted -1.422 Total Piston Stroke +2.886
2.1.5	Feedback Potentiometer Continuity, Linearity, and Travel	See figure 3.	Extend: ABCD = 0.462 EFGH = 0.460 Retract: ABCD = 0.460 EFGH = 0.458
2.1.6	Coil Resistance	100±5 ohms at 100°F	98 ohms
2.1.7	Dielectric Breakdown	No breakdown at 1,000 vdc for 60 seconds	No breakdown

TABLE 3. ACTUATOR ACCEPTANCE TEST RECORD,
TEST SPECIMEN NO. 4 (CONTINUED)

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1.8	Potentiometer Resistance	Pins Ohms A & C 2,000±200 G & E 2,000±200 B & D 450 min., 700 max. F & H 450 min., 700 max.	Ohms 1,975 1,877 521 505
2.1.9	Servovalve Polarity	A+, B- : Retract B+, A- : Extend	A+, B- : Retracted B+, A- : Extended
2.1.10	Flow	10.5±1.5 gpm at 100°F	10.2 gpm
2.1.11	Internal Leakage	0.2 gpm min. 0.4 gpm max.	0.35 gpm
2.1.12	Static Seal Leakage	No external leakage	None
2.1.13	Piston Rod End Dynamic Seal Leakage	4 drops max.	1 drop
2.1.14	Piston Packing Friction	100 psid	19 psid
2.1.15	Actuator Gain	0.031±0.0016 in./ma	Extend: 0.0295 Retract: 0.0298
2.1.16	Flow Gain	5.25 cis/ma ±10% (from 1.227 to 1.499 gpm per ma)	1.23 gpm/ma Run 1 1.27 gpm/ma Run 2
2.1.17	Frequency Response	Max. Amplitude Ratio: 3.5 db Max. Phase Lag: 35° at 1 cps	Max. Amplitude Ratio: 3 db Phase Lag: 29° at 1 cps NOTE: See Charts 3-5 and 3-6.

2.2 Operational Environmental Tests

This group of tests was conducted to determine the operational qualifications of the actuator under various environmental conditions. Figure 4 is a schematic diagram of the hydraulic circuit used for these tests.

2.2.1 Temperature Environmental Response

2.2.1.1 Requirements

The test specimen shall exhibit the following closed-loop (load/current) response characteristics at high and low temperatures, while driving a simulated engine spring-mass load (36.6 radians per second) and while being excited by sinusoidal driving commands. Amplitude peaking shall be less than 50 per cent (3.5 db) above nominal amplitude ratio at all frequencies for command current (I_c) of 3.5 ma zero-to-peak, and above. Phase lag shall be less than, or equal to, 35 degrees up to and including 1.0 cps for the 3.5-ma zero-to-peak input. The preceding requirements shall apply for ambient environmental temperature conditions with the fluid temperature maintained at 100°±10°F and also shall apply for frequency response tests performed at temperatures ranging from -35° to +275°F.

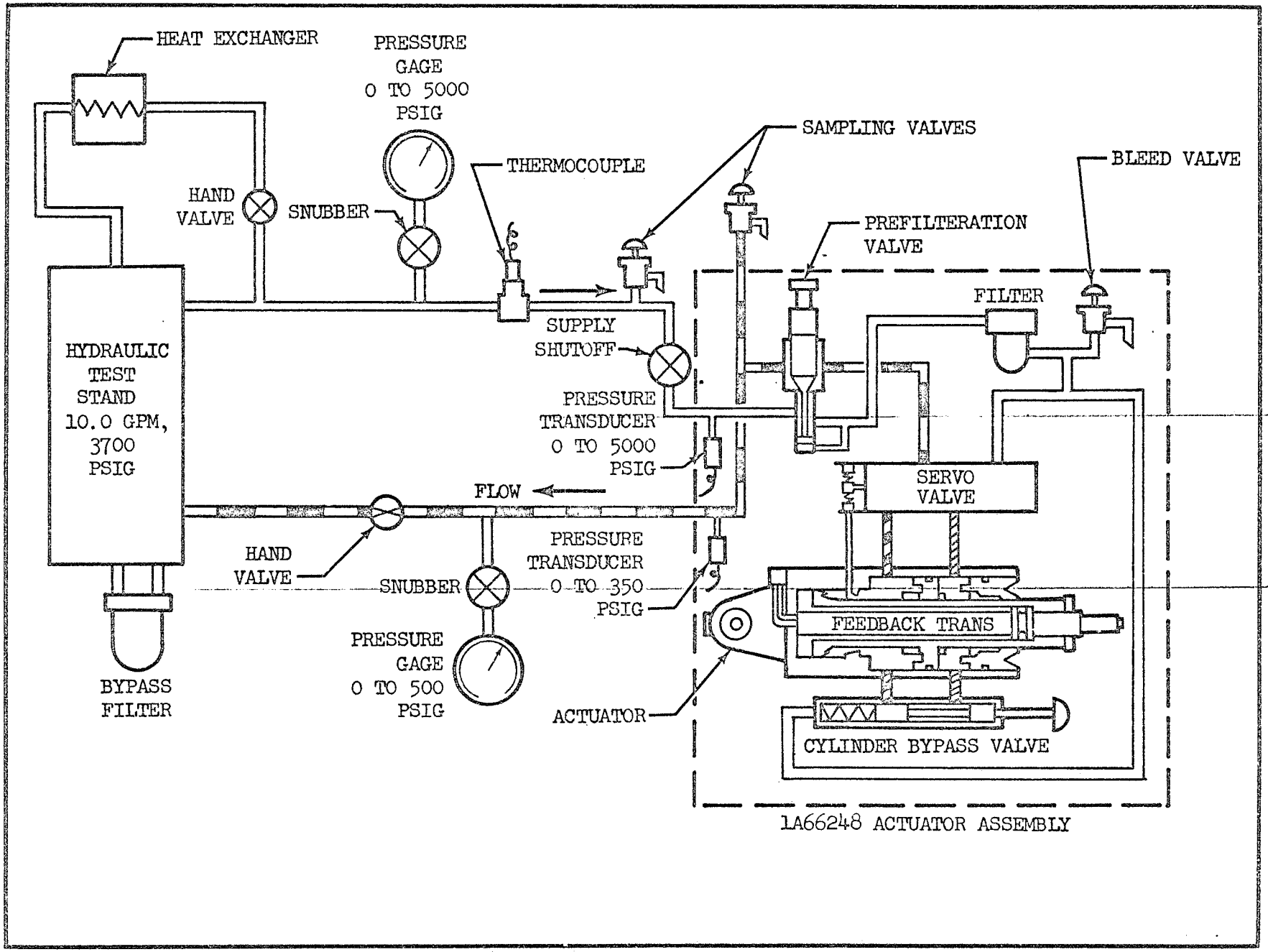


Figure 4. Hydraulic Circuit for Operational Environmental Tests, Schematic Diagram

2.2.1.2 Procedure

Temperature environmental response tests were performed on test specimen No. 3 to determine actuator response capability through anticipated environmental high- and low-temperature extremes. Frequency response data, maximum no-load velocity (piston rate), and piston null shift information were obtained for environmental and fluid temperatures ranging from +275° to -35°F. The actuator was installed in the single-axis engine-load simulator, located in the environmental chamber. This test setup is shown in figures 5, 6, and 7. The fluid and chamber temperatures were stabilized at the desired test temperatures for 10 to 15 minutes before starting each test run.

2.2.1.2.1 Frequency Response

The frequency response test was used here as a standard performance test to denote performance variation resulting from the applied temperature environments. In all cases, the frequency response test was performed with the test specimen installed on the single-axis engine-load simulator. The spring-mass (no artificial dampening) resonance of the single-axis engine-load simulator was 36.3 radians per second. Sinusoidal servo-driving signals for the frequency tests were provided by the RW-300 automatic servo test system, utilizing the dual channel servo control unit shown in Appendix 2, figures 2-6 and 2-7. The automatic servo test system also monitored the command signals and three data channels: (1) valve input current, (2) piston position feedback, and (3) load position.

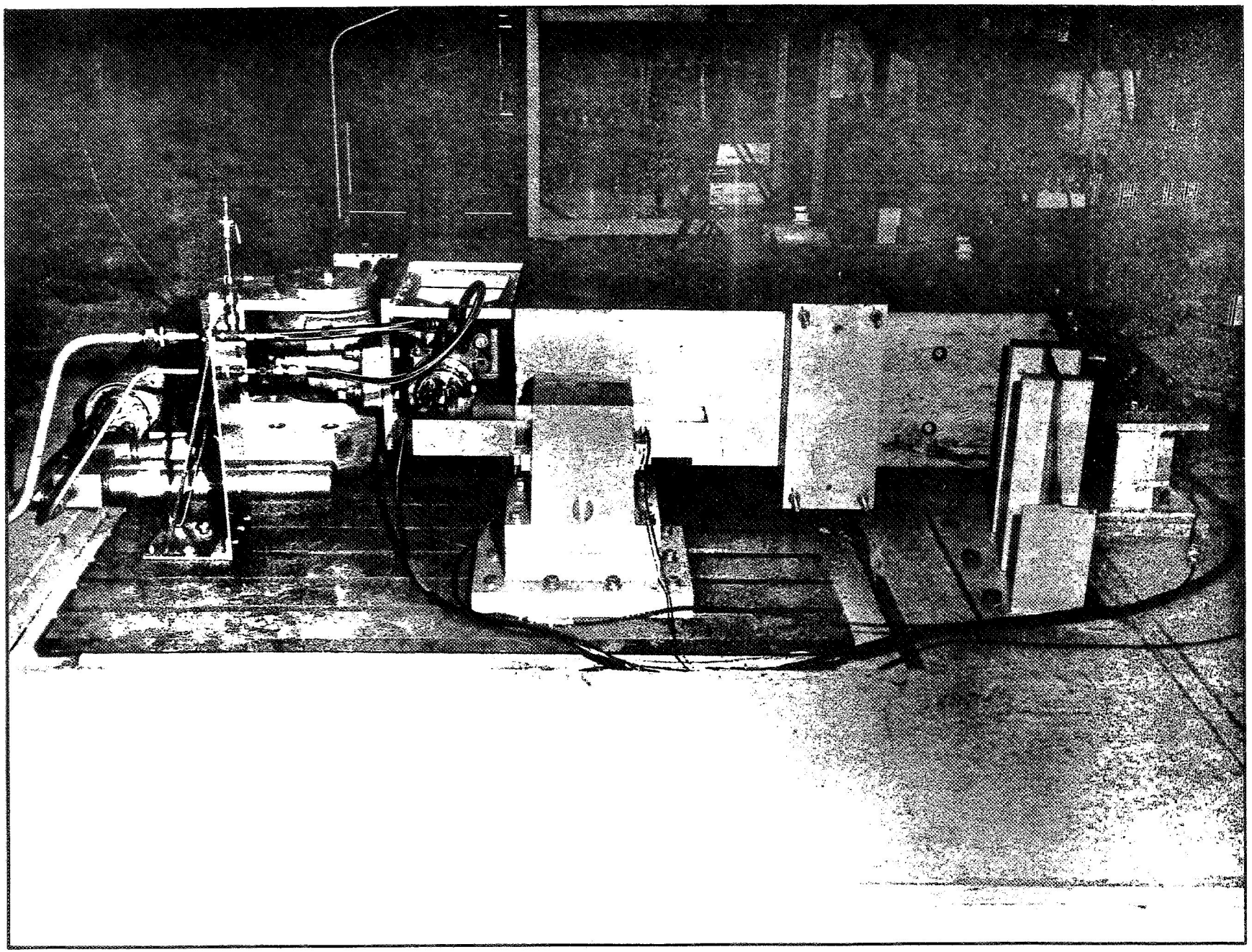


Figure 5. Temperature Environmental Response Test Setup

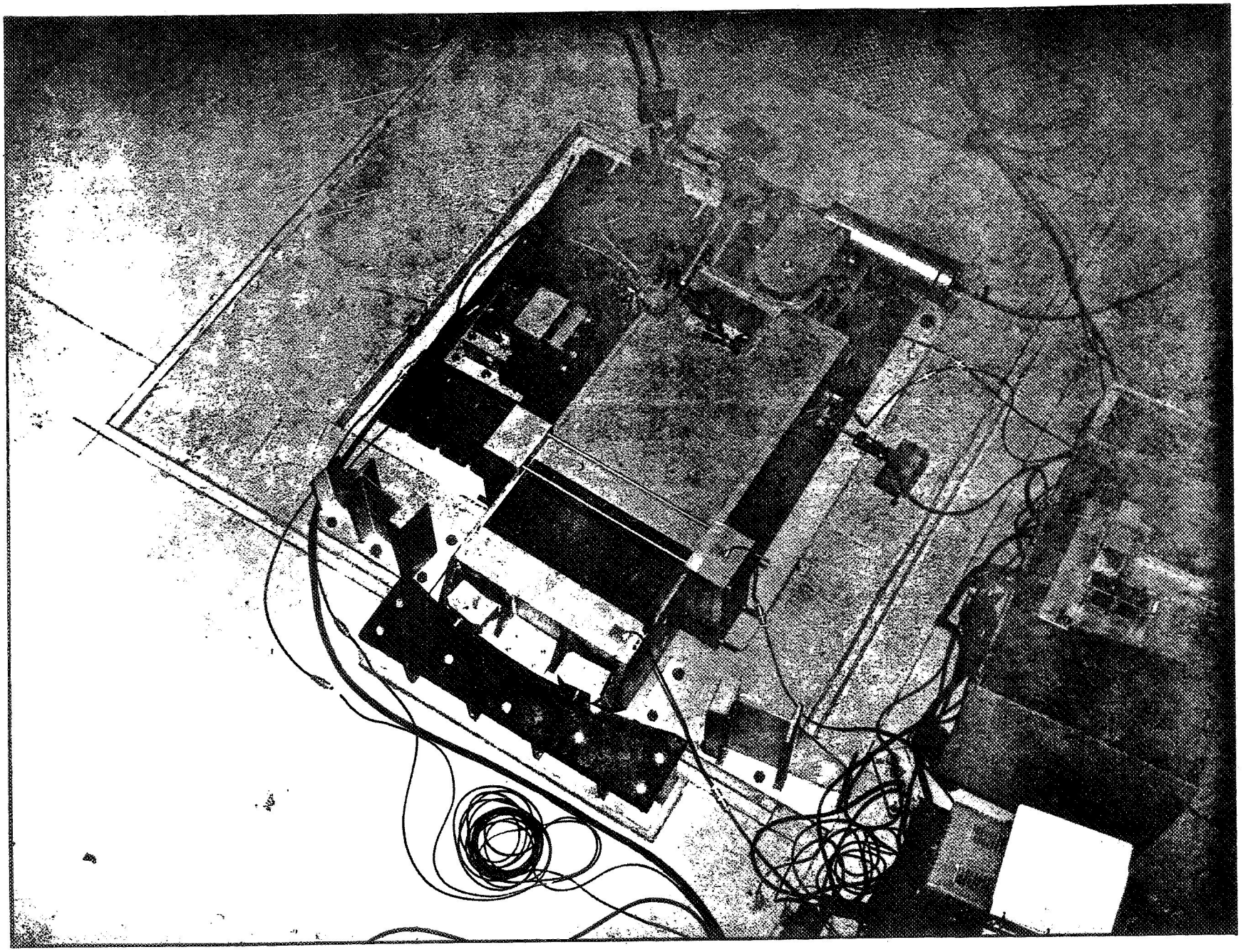


Figure 6. Temperature Environmental Response Test, Plan View

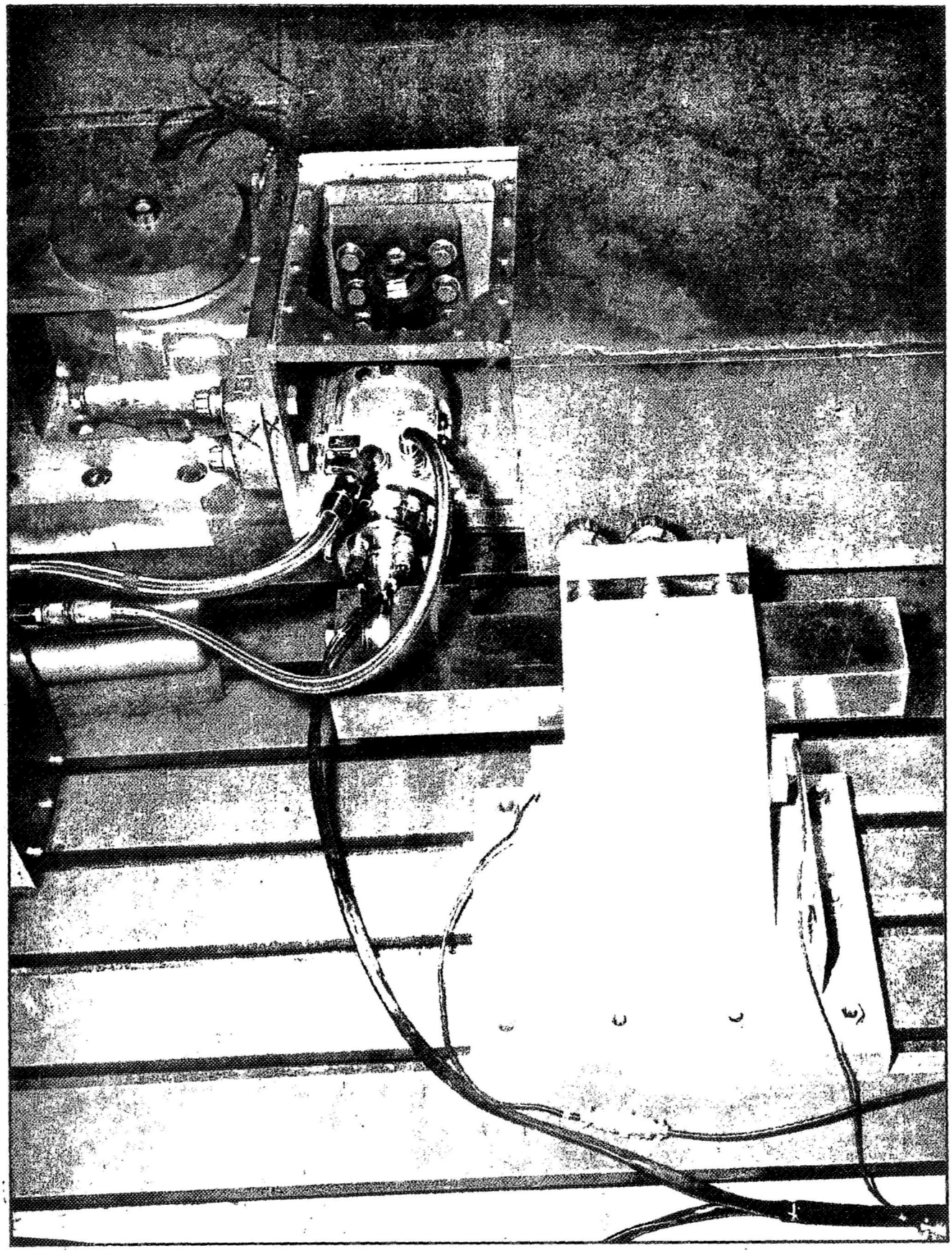


Figure 7. Temperature Environmental Response Test, Actuator Detail

2.2.1.2.1. (Continued)

Valve input current, I_c, was measured across a 100-ohm resistor in series with the valve coil. The amplitude numbers in the frequency response tables (Appendix 4, Tables 4-4 through 4-8) refer to peak-to-peak voltages measured across the 100-ohm resistor. Piston position feedback was measured from the actuator feedback element. The gain of this position-indicating device is 0.326 v/in./v. Peak-to-peak excitation voltages ranged from 6.0 to 21.0 vdc, depending upon the actuator control unit used.

Load position was monitored with a linear potentiometer located the same distance from the simulator pivot as the actuator piston attach point. Gain of the load position potentiometer was 0.310 v/in./v. Excitation voltage for the load potentiometer was 6.0 volts peak-to-peak. Excitation voltages for the piston and load potentiometers are given in Tables 4-4 through 4-8. The four channels monitored were controlled by the automatic servo test system to yield the desired servo amplitude and phase-angle relationships. Response tests were run for constant valve input-current amplitudes of 1.7 ma, 3.5 ma, and 6.7 ma, all peak-to-peak, at each driving frequency. Test frequencies ranged from 0.5 to 20.0 cps. The preceding valve current inputs correspond to engine displacements of 0.25 degree peak-to-peak, 0.50 degree peak-to-peak, and 1.0 degree peak-to-peak, respectively.

2.2.1.2.2 Unloaded Maximum Velocity

With the actuator installed in the engine-load simulator, maximum piston velocity resulting from an applied step command of approximately one

half of maximum stroke was measured. Piston-position feedback was monitored with a recording oscillograph. Piston rates were obtained from the oscillograph traces.

2.2.1.2.3 Actuator Piston Null Position

Actuator piston null excursions, indicated by the piston position feedback transducer, were observed at the different temperature conditions. The measured null information was obtained with no signal to the valve coil.

2.2.1.3 Results

Charts 3-7 and 3-8 in Appendix 3 are frequency response curves for the two different types of actuator driver amplifiers used in the temperature environmental response tests. These amplifiers are not included within the actuator servo loop but are external and hence do not directly affect actuator response. The response of the combined amplifier and servo would be of interest when considering the engine control loop in relation to the vehicle auto-pilot.

The two amplifiers represented by charts 3-7 and 3-8 are the Douglas-designed ground support equipment or laboratory-development test amplifier and a breadboard version of the NASA vehicle flight amplifier, respectively. Both amplifiers demonstrated adequate amplitude and phase

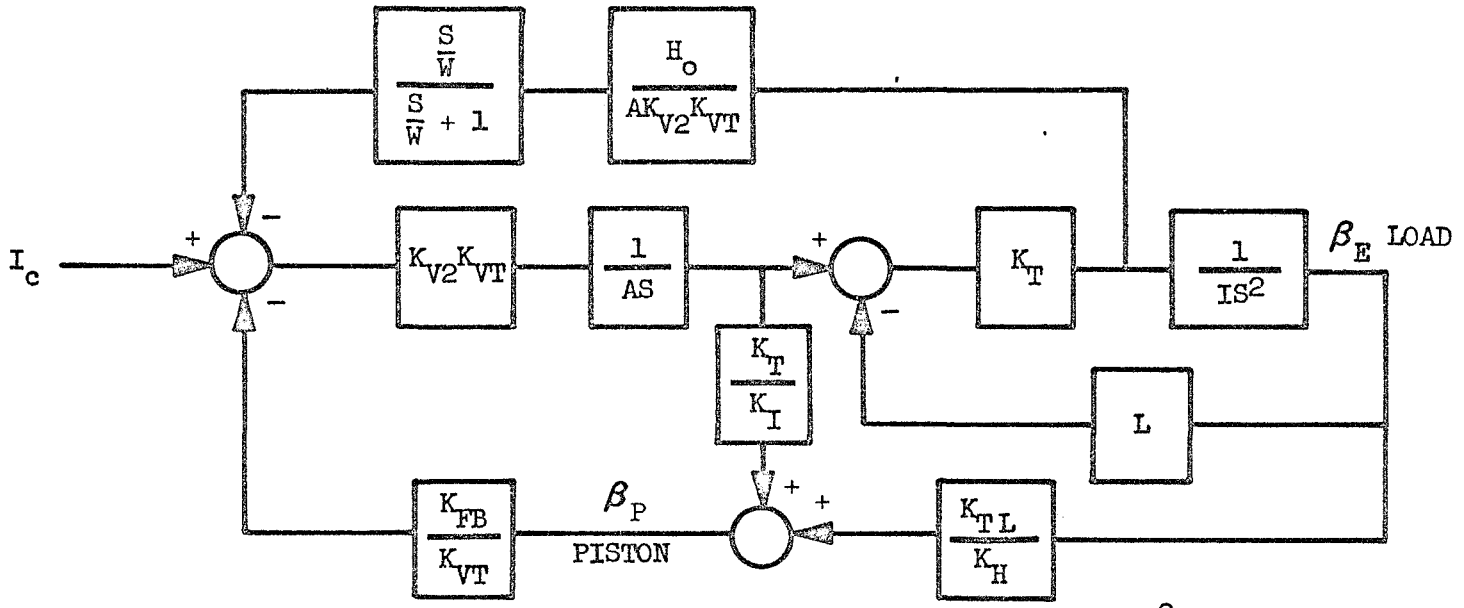
2.2.1.3 (Continued)

response throughout the frequency range of the servo. Amplitude nonlinearity for commands of ±1/8, ±1/4, and ±1/2 degree was less than 1.0 db for both units. Initially, the NASA amplifier exhibited a rather large-amplitude high-frequency (1,000 cps) noise when attached to the S-IVB actuator with hydraulics. The noise was traced to faulty installation of the dc-power source supplying the amplifier. Correction of this error reduced the noise to a much lower level (less than 2 ma).

Figure 8 and charts 3-9 through 3-11 comprise a linear single-axis analytical presentation of the S-IVB servo as related to the empirical information contained in this section. The load, piston, and I_c positions of the block diagram in figure 8 represent the equivalent locations of the test servo loop.

Charts 1 through 5, charts 3-12 through 3-16, and Tables 4-4 through 4-8 present empirical data and curves for dynamic response at various temperatures. Chart 3-12 is an amplitude response curve of the spring-mass load simulator. As the curve reveals, the test fixture was conservative, or underdamped, with an undamped resonant frequency of 36.3 radians per second for the ±0.5-degree engine-displacement amplitude. Chart 3-9 shows the similarity of the analytical representation of the same curve.

Table 4 summarizes the results of the high- and low-temperature frequency response tests. As the table indicates, room-temperature performance requirements were satisfied for all of the tests performed. Variations in dynamic response, caused by temperature effects, were negligible. At no time during the testing did the test specimen malfunction or indicate erratic or unacceptable performance.



I	ENGINE SIMULATOR MOMENT OF INERTIA: 17,300 LB-SEC^2-IN. or $\frac{120 \text{ LB-SEC}^2}{\text{IN.}}$
K_T	COMBINED HYDRAULIC, STRUCTURAL, ENGINE COMPLIANCE: 118,500 LB/IN.
K_I	COMBINED STRUCTURAL, ENGINE COMPLIANCE: 159,000 LB/IN.
K_H	HYDRAULIC COMPLIANCE (ACTUATOR): 458,000 LB/IN.
W	DPF NETWORK CORNER FREQUENCY: 7.5 RADIANS/SEC
L	ACTUATOR MOMENT ARM: 12 IN.
A	ACTUATOR PISTON EFFECTIVE AREA: 11.78 IN.^{2}
H_o	ACCELERATION FEEDBACK GAIN: 0.015 CIS/PSI
K_{V2} K_{VT}	VALVE FIRST AND SECOND STAGE GAIN: 5.25 CIS/MA
K_{FB}/K_{VT}	MECHANICAL PISTON POSITION EQUIVALENT FEEDBACK GAIN: 32.2 MA/IN.
W_I	SIMULATOR STRUCTURAL RESONANCE: $\frac{K_I L^2}{I}$ = 36.3 RADIANS/SEC
I_c	CURRENT TO ACTUATOR
β_E LOAD	ENGINE POSITION, β_P PISTON PISTON POSITION

Figure 8. Block Diagram of Engine Actuator Servo

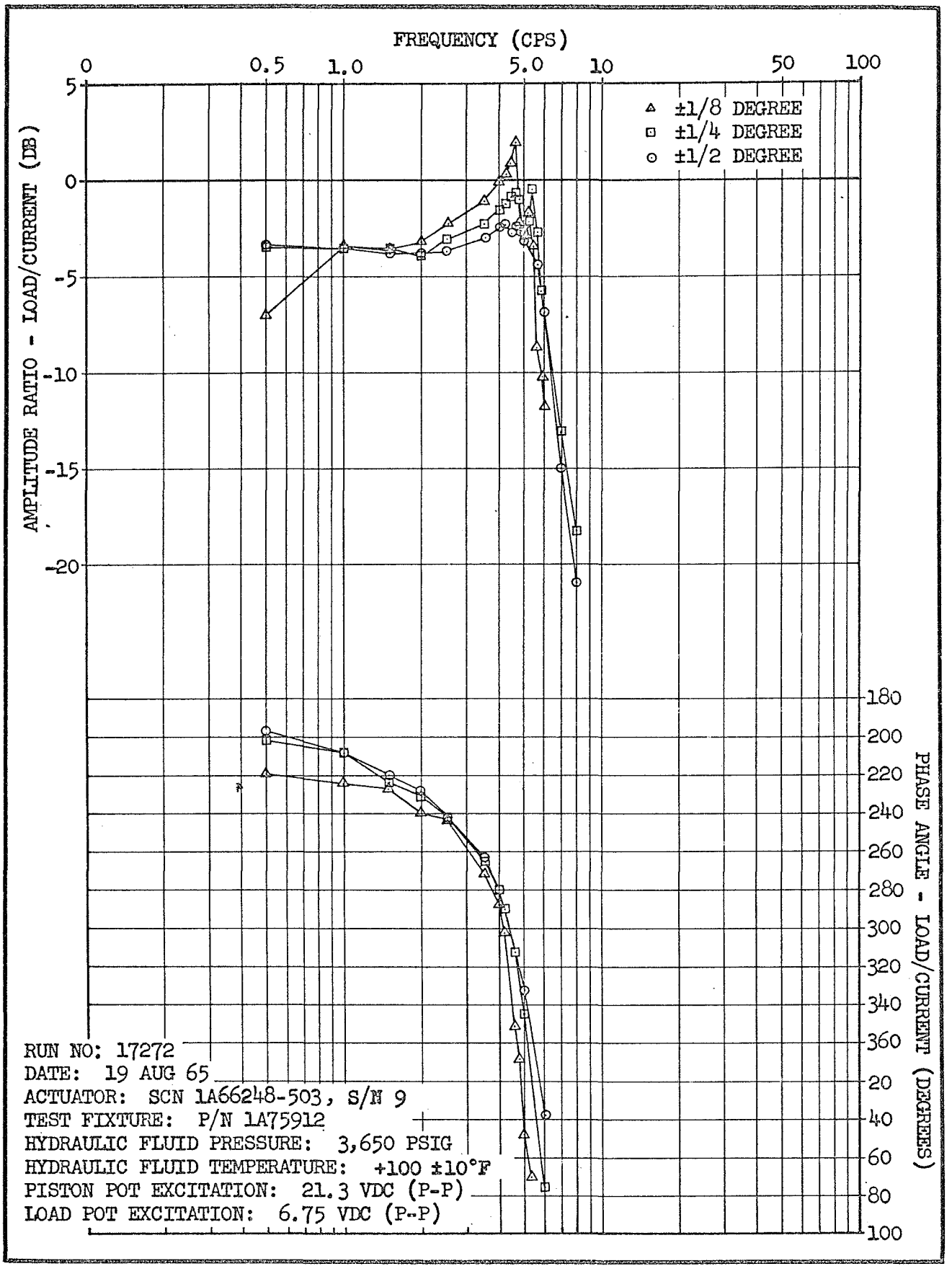


Chart 1. Pre-environmental Frequency Response at Room Temperature, Load/Current - Test Specimen No. 3

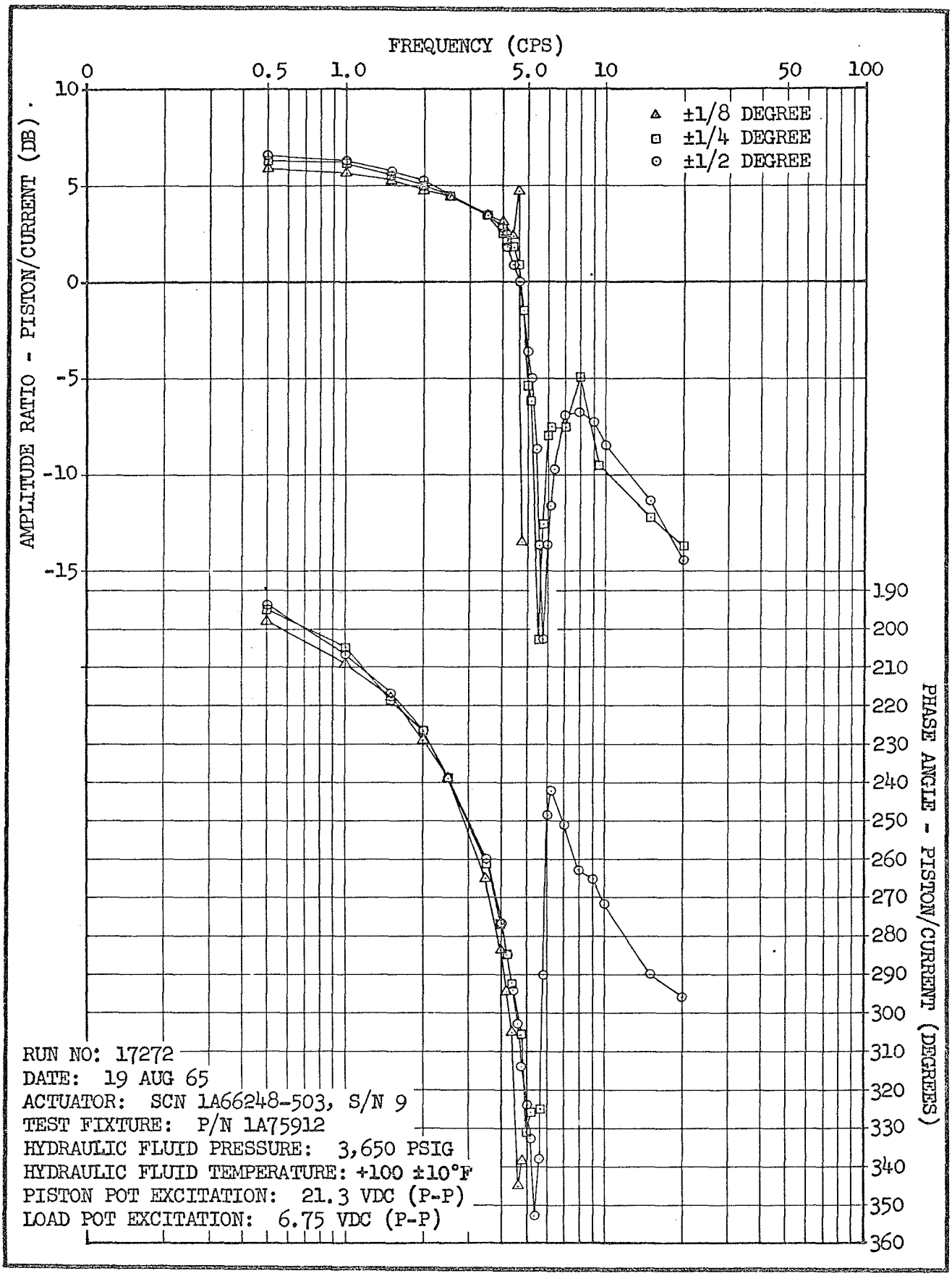


Chart 2. Pre-environmental Frequency Response at Room Temperature, Piston/Current - Test Specimen No. 3

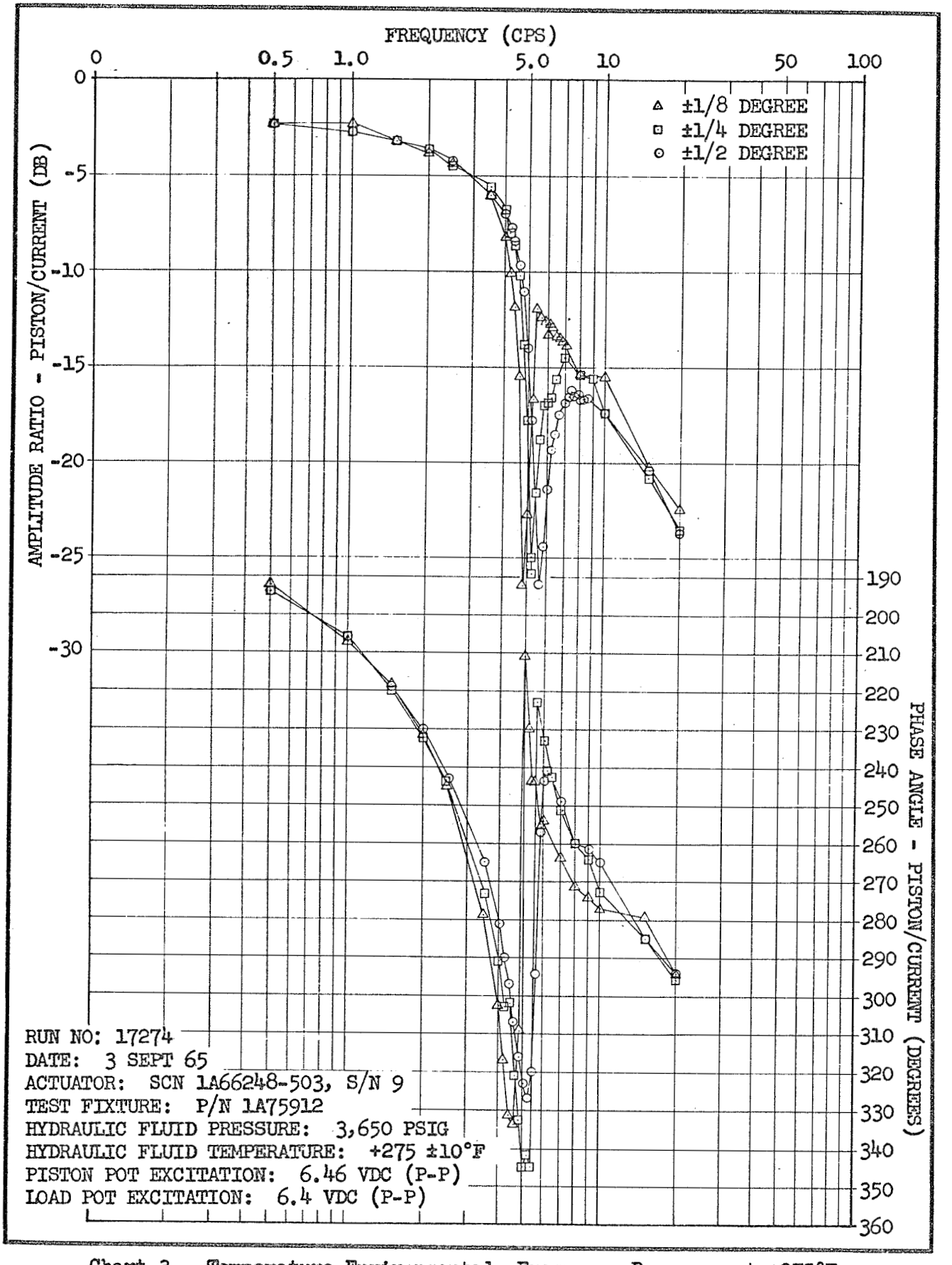


Chart 3. Temperature Environmental Frequency Response at +275°F, Piston/Current - Test Specimen No. 3

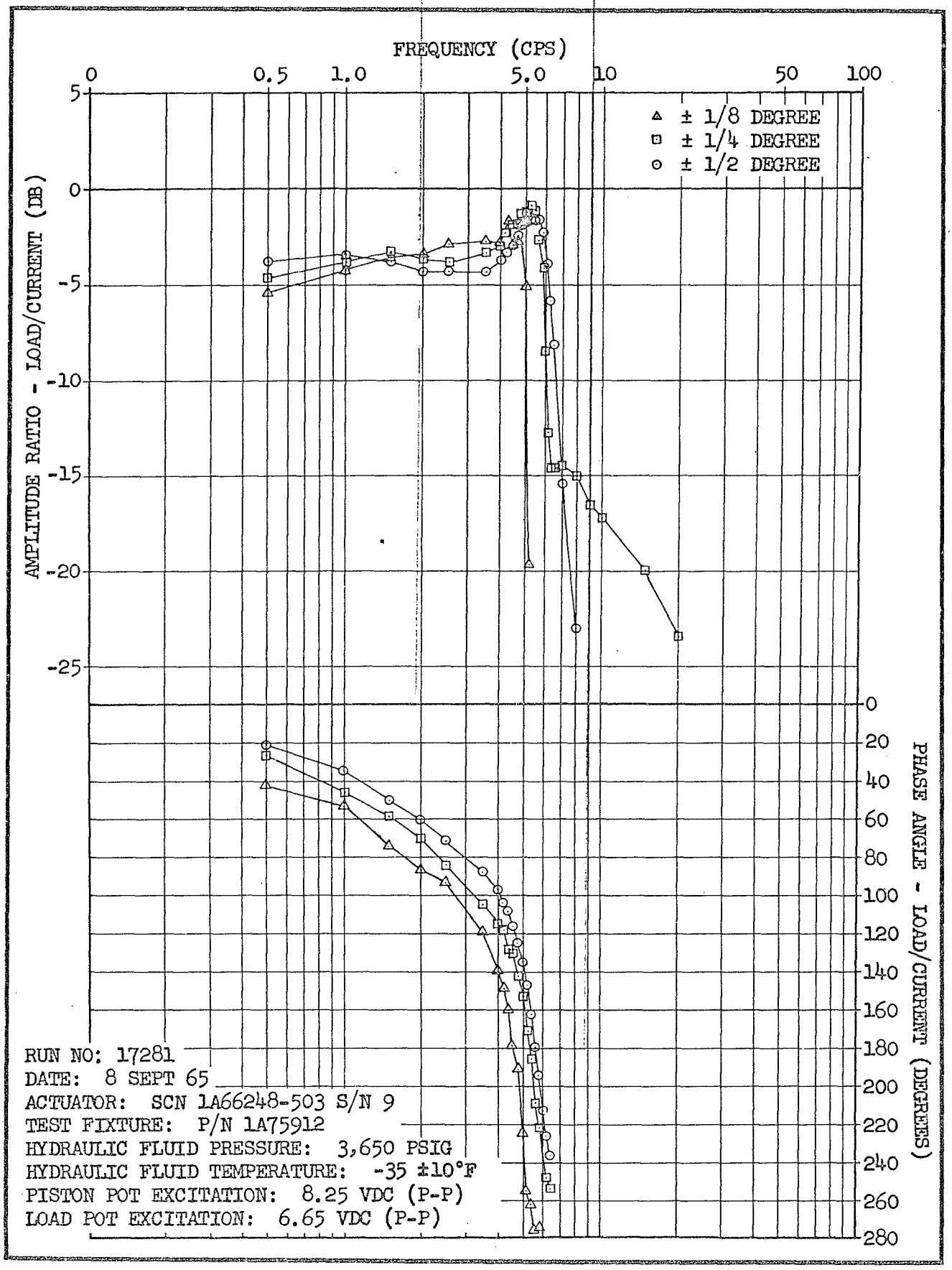


Chart 4. Temperature Environmental Frequency Response at -35°F, Load/Current - Test Specimen No. 3

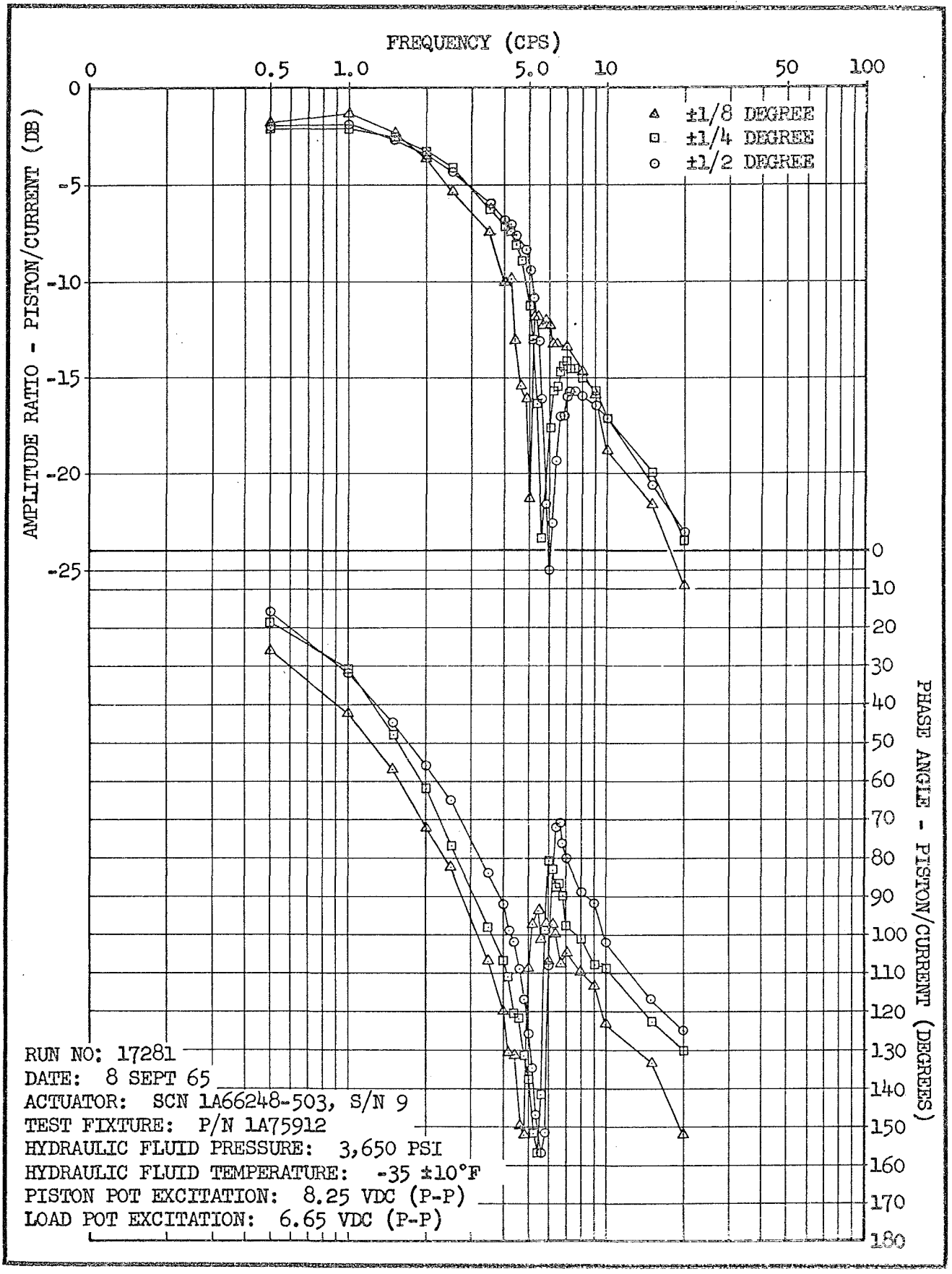


Chart 5. Temperature Environmental Frequency Response at -35°F, Piston/Current - Test Specimen No. 3

TABLE 4. TEMPERATURE ENVIRONMENTAL RESPONSE TEST RESULTS, TEST SPECIMEN NO. 3

TEST	ROOM TEMPERATURE REQUIREMENTS				
	LESS THAN +3.5 DB	LESS THAN 35 DEG		±0.0316 IN.	MIN 9.0 GPM MAX 12.0 GPM
	MAXIMUM LOAD/ CURRENT AMPLITUDE PEAKING (DB)	1.0 CPS LOAD/ CURRENT PHASE ANGLE FOR +0.5 INPUT (DEGREES)	AMPLITUDE NON-LINEARITY (DB)	PISTON NULL DISPLACEMENT WITH VALVE COIL OPEN (INCHES)	NO-LOAD MAXIMUM FLOW RATE (PISTON VELOCITY (GPM)
+275°F	----	28	0.5	0.005	11.1
+100°F	+1.5	28	1.0	0.0276	10.9
0°F	+3.5	29	0.5	0.0276	9.65
-35°F	+2.5	35	1.5	0.012	9.45
POST ENVIRON. ROOM TEMP	+3.0	29	1.0	---	----

2.2.2 Room-Temperature Vibration

2.2.2.1 Requirements

2.2.2.1.1 Sinusoidal Sweep Test

There shall be no evidence of damage, malfunction, or performance degradation when the actuator assembly is subjected to sinusoidal vibration at room temperature in each of three mutually perpendicular directions. The frequency range shall be scanned logarithmically at the rate of 1.00 octave per minute, from 20 to 2,000 cps (6 2/3 octaves) and back to 20 cps, and the frequencies shall be noted for all conditions of resonance in each direction. The input levels shall be:

20 to 250 cps	9.6-g peak
250 to 344 cps	0.000305-inch D.A.
344 to 2,000 cps	18.2-g peak

2.2.2.1.2 Random Vibration Test

There shall be no evidence of damage, malfunction, or performance degradation when the actuator assembly is subjected to random excitation at room temperature for 25 minutes in each of three mutually perpendicular directions. The excitation shall be applied as one input of 0.29 g^2/cps over the frequency interval from 20 to 2,000 cps.

2.2.2.2 Procedure

Room-temperature vibration tests were performed on two actuators, test specimens No. 3 and 4, with the fluid and environment at room temperature and with the test actuators including flight instrumentation. The differential-pressure transducer and temperature transducer were installed and monitored. The actuator attach bolts were vehicle flight configuration. The diametrical clearance of the test fixture piston slide was 0.0005 inch. Figures 9 and 10 show the test setup, with the actuator in the holding fixture mounted on the shaker.

Hydraulic fluid at 100° to 120°F temperature and 3,650-psig supply pressure was applied to the actuator during all test runs. Return pressure was maintained between 50 and 60 psig. The holding fixture permitted unloaded cycling of the actuator. During initial sinusoidal and random runs in the radial direction on test specimen No. 3, a sinusoidal command of 75 per cent of piston stroke (peak-to-peak) at 0.5 cps was applied to the actuator. This cycling rate was considered too fast and was reduced to 75 per cent of stroke at 0.2 cps for subsequent runs.

Data monitored during the tests included valve current, piston position feedback (telemetry feedback was not monitored), cylinder fluid temperature, cylinder differential pressure, and acceleration from the six accelerometers on the surface of the test specimen. All of these functions were monitored with an oscillograph for direct readout. In addition to the oscillograph data, the accelerometer outputs were recorded on magnetic tape for reduction at a later time. The control

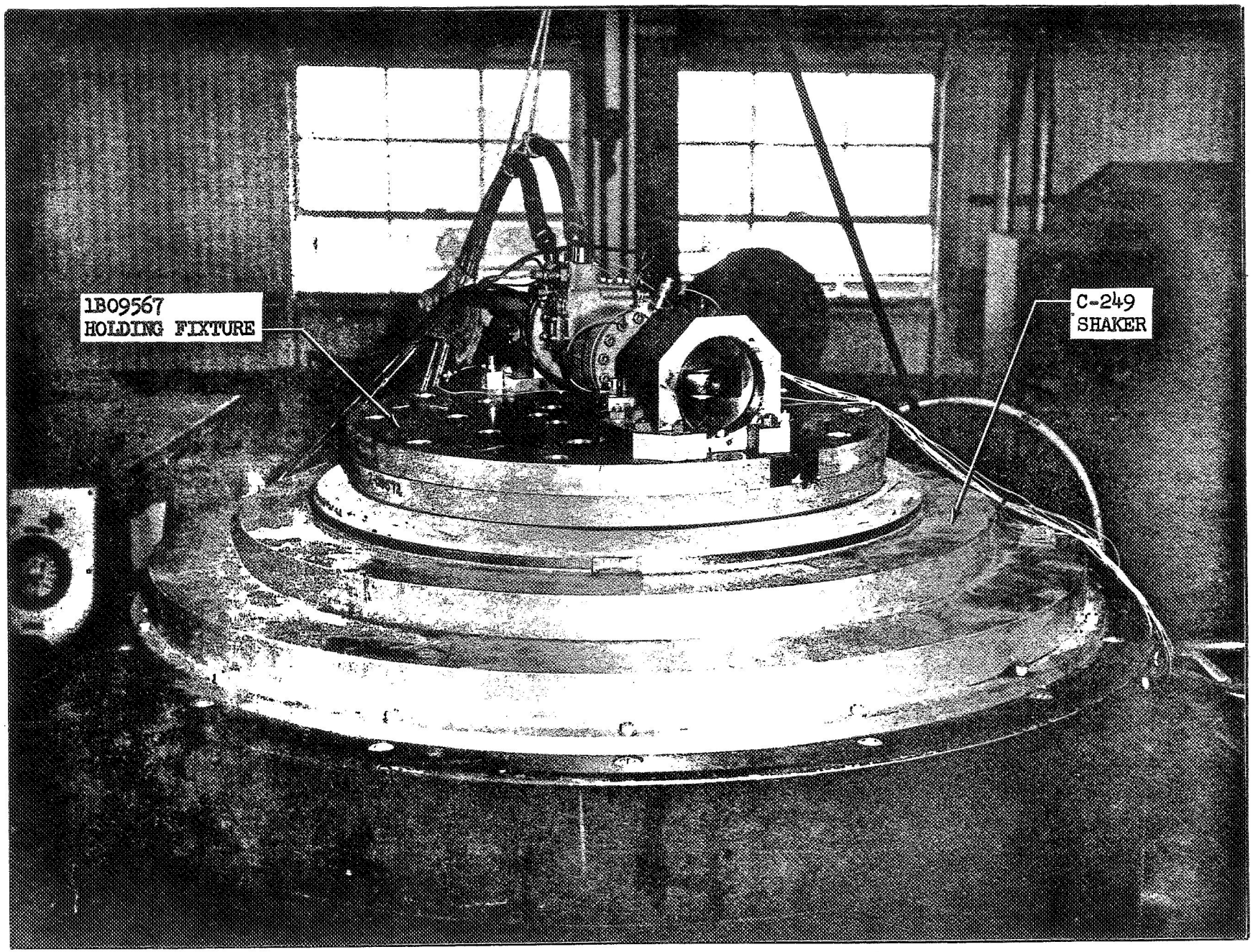


Figure 9. Room-Temperature Vibration Test Setup

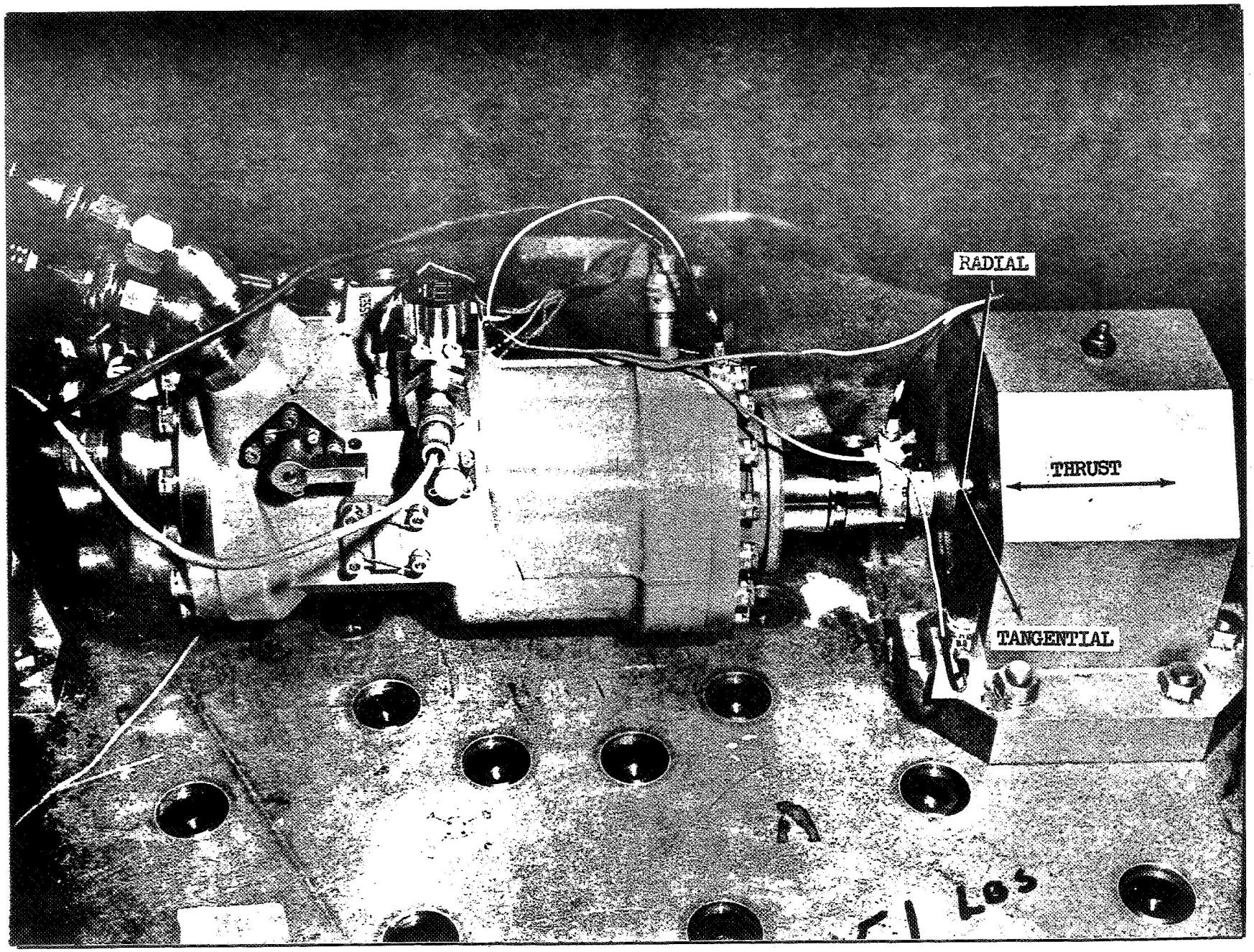


Figure 10. Room-Temperature Vibration Test Setup, Side View

2.2.2.2 (Continued)

accelerometer for the room-temperature vibration equipment was located at the base of the tail-end bracket. Table 5 lists the test sequence and test conditions for the room-temperature vibration tests.

2.2.2.3 Results

Both test specimens performed satisfactorily throughout vibration testing. There was no evidence of damage, malfunction, or performance degradation of either specimen. Refer to the post-room-temperature frequency response test results in charts 6 through 9 and Tables 4-9 and 4-10. Piston-position traces were continuous and uninterrupted.

2.2.3 High-Temperature Vibration

The objective of the high-temperature vibration tests was to subject the actuator to the required vibration levels while maintaining a hydraulic fluid temperature of +275°F, and a steady cyclic load of 1,200 psid across the actuator piston. Particular interest was focused on possible performance degradation because of the combined environments of high temperature and vibration and possible excitation of the amplifier valve intercoupling problem.

TABLE 5. ROOM-TEMPERATURE VIBRATION TESTS

ACTUATOR TEST SPECIMEN NO.	DATE	TEST	AXIS	COMMAND INPUT
3	20 April 1965	Sine: 0 to 2,000 2,000 to 0	Radial	75% stroke at 0.5 cps
3	20 April 1965	Random 25 min.	Radial	75% stroke at 0.5 cps
3	27 April 1965	Sine: 0 to 2,000 2,000 to 0	Thrust	75% stroke at 0.2 cps
3	27 April 1965	Random 25 min.	Thrust	75% stroke at 0.2 cps
3	28 April 1965	Sine: 0 to 2,000 2,000 to 0	Tangential	75% stroke at 0.2 cps
3	28 April 1965	Random	Tangential	75% stroke at 0.2 cps
4	29 April 1965	Sine: 0 to 2,000 2,000 to 0	Tangential	75% stroke at 0.2 cps
4	29 April 1965	Random 25 min.	Tangential	75% stroke at 0.2 cps
4	29 April 1965	Sine: 0 to 2,000 2,000 to 0	Thrust	75% stroke at 0.2 cps
4	29 April 1965	Random	Thrust	75% stroke at 0.2 cps
4	30 April 1965	Sine: 0 to 2,000 2,000 to 0	Radial	75% stroke at 0.2 cps
4	30 April 1965	Random	Radial	75% stroke at 0.2 cps

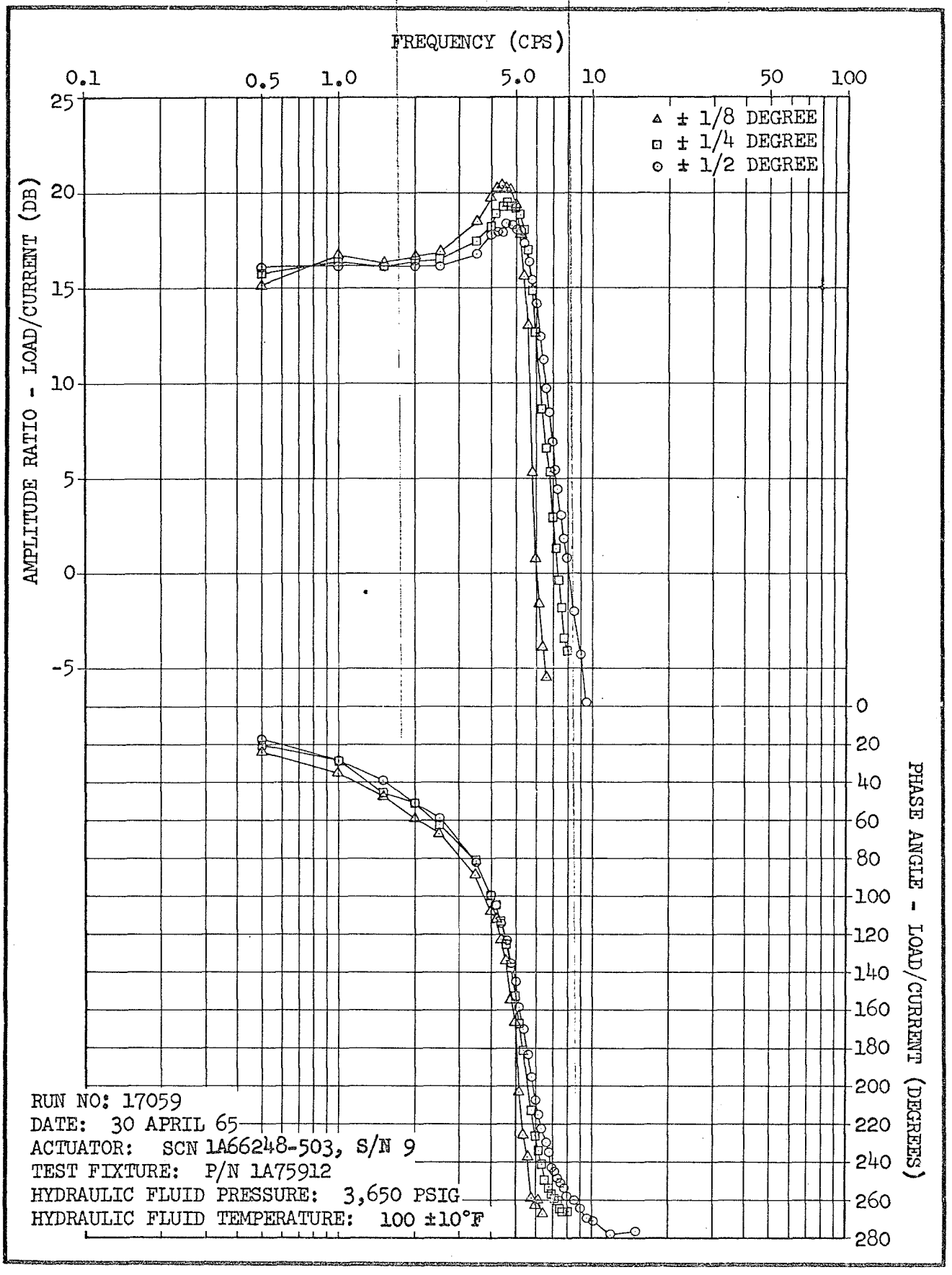


Chart 6. Post-Room-Temperature Vibration Frequency Response, Load/Current - Test Specimen No. 3

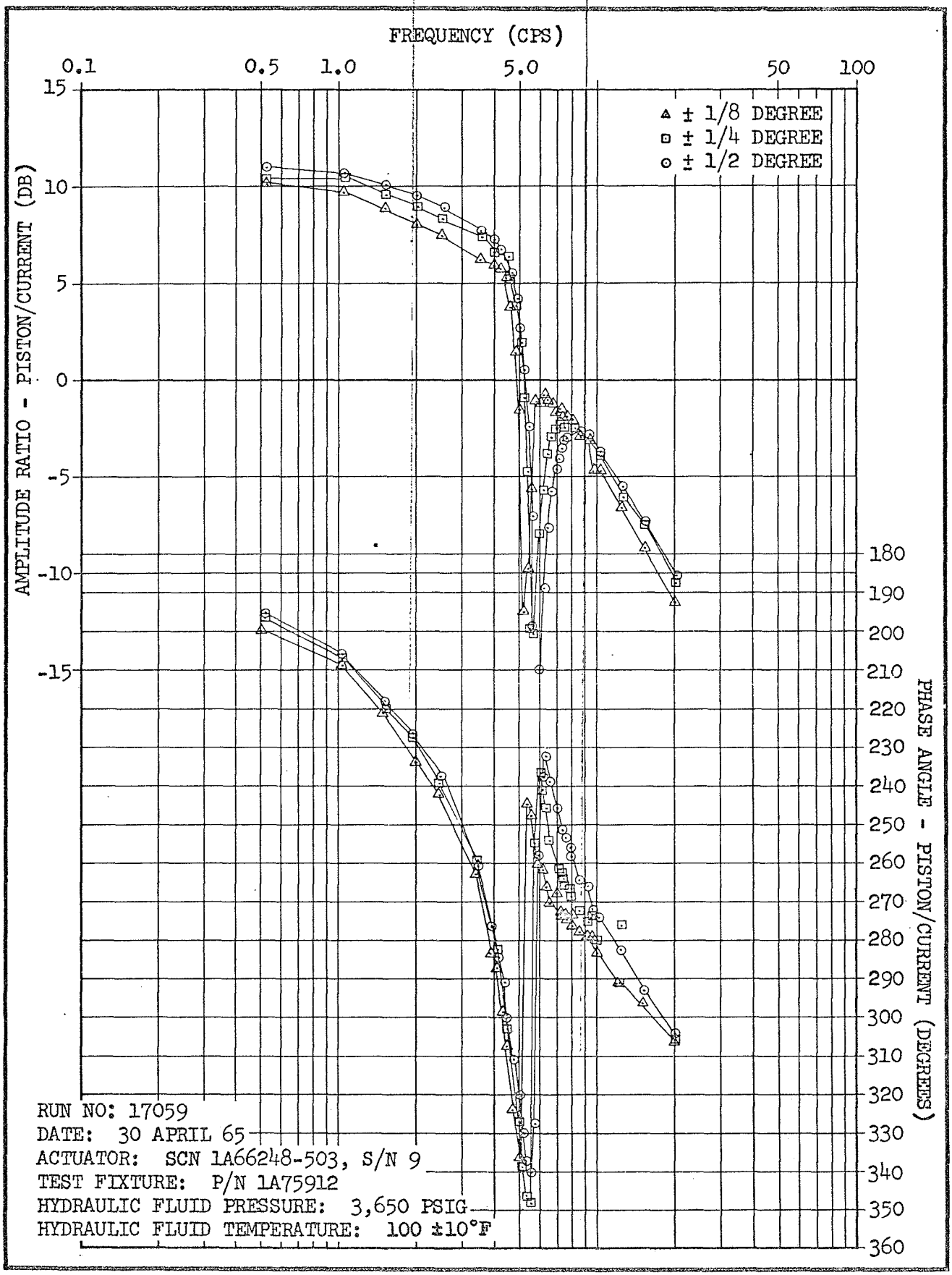


Chart 7. Post-Room-Temperature Vibration Frequency Response, Piston/Current - Test Specimen No. 3

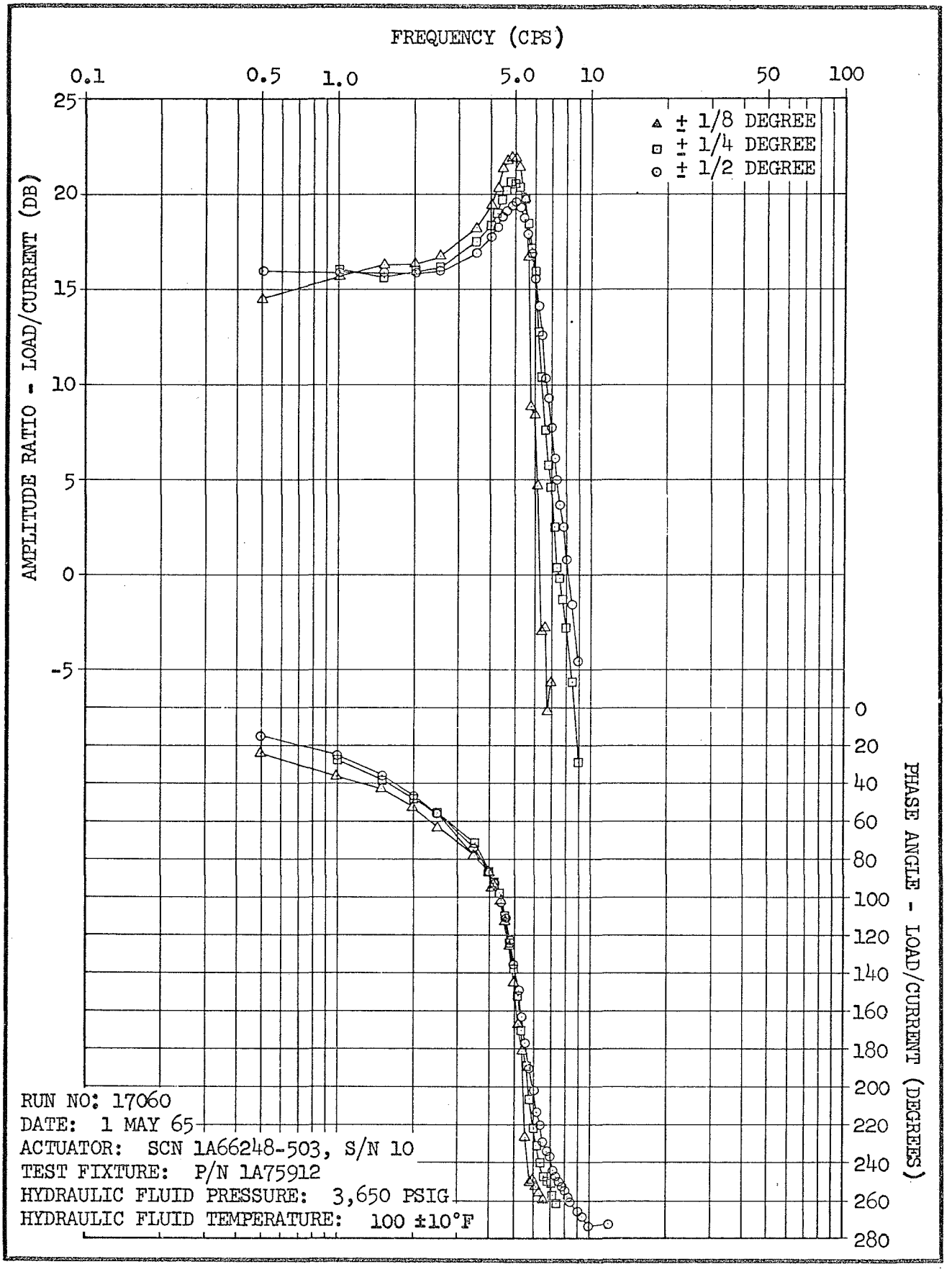


Chart 8. Post-Room-Temperature Vibration Frequency Response, Load/Current - Test Specimen No. 4

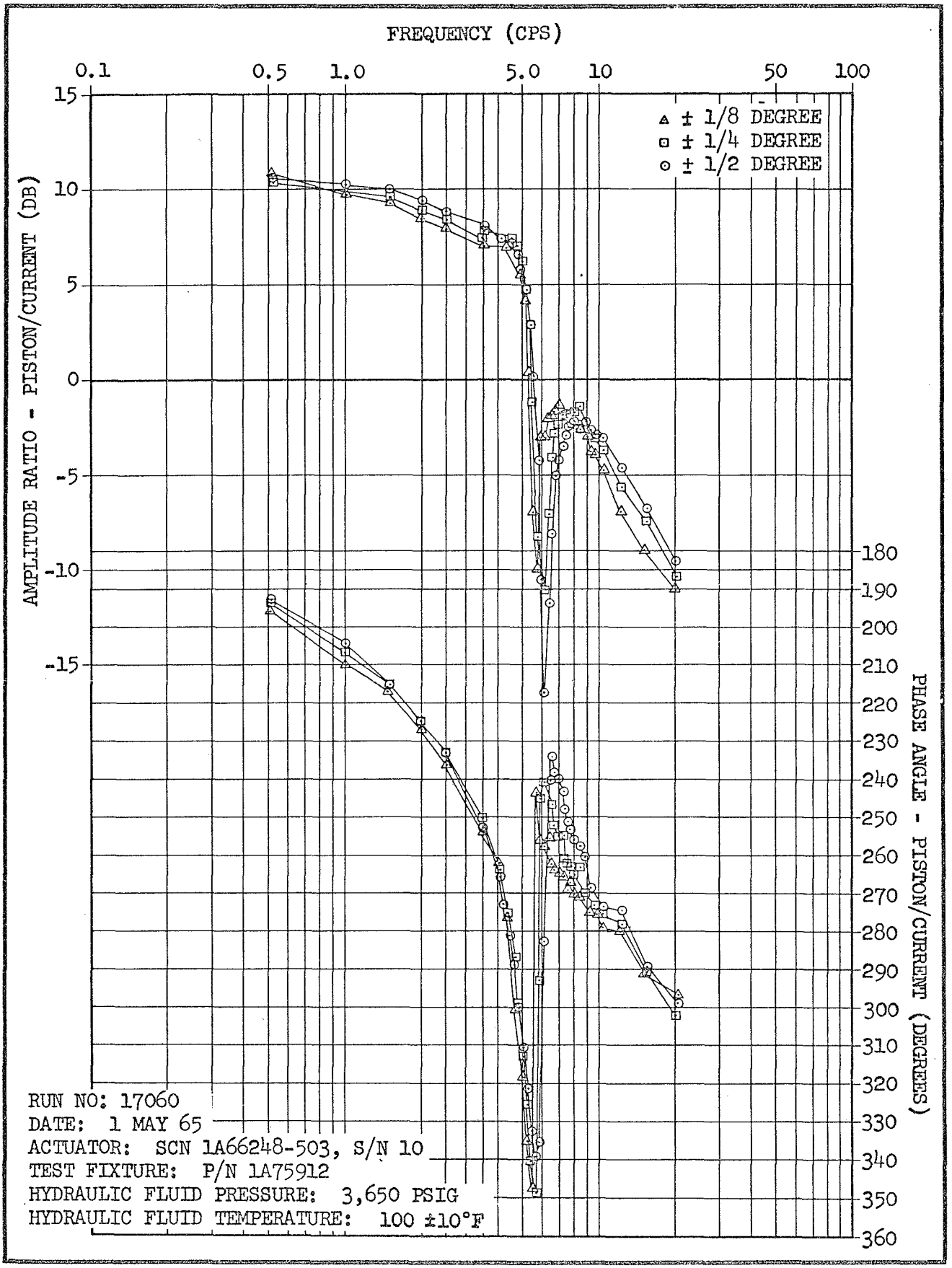


Chart 9. Post-Room-Temperature Vibration Frequency Response, Piston/Current - Test Specimen No. 4

2.2.3.1 Requirements

There shall be no evidence of damage, malfunction, or performance degradation when the actuator assembly is subjected to the following high-temperature vibration requirements. With the test specimen mounted in the load test fixture, hydraulic fluid at +275°F shall be applied to the actuator at pressures of 3,650-psig supply and 50- to 100-psig return. The test environment shall be room temperature. A triangular command signal of ±30 ma at 1.0 cps shall be applied to the actuator. The actuator cylinder differential pressure shall be 1,200 psid. Under the foregoing conditions, the test specimen shall be subjected to the sinusoidal and random vibration applications described in paragraphs 2.2.2.1.1 and 2.2.2.1.2. Hydraulic supply and return pressures, cylinder differential pressure, valve input current, telemetry feedback, and position feedback shall be monitored.

2.2.3.2 Procedure

Test specimen No. 3 was mounted on the actuator high-temperature vibration support fixture, as shown in figure 11, for successive vibration runs in the radial, tangential, and thrust directions. The following procedure was observed during each test run.

With 3,650-psig hydraulic supply pressure applied to the actuator, the hydraulic fluid reservoir temperature of the test stand was increased and stabilized at +275°F. A triangular wave input of ±30 ma at 0.35 cps was applied to the actuator. Chamber pressure of the load mechanism

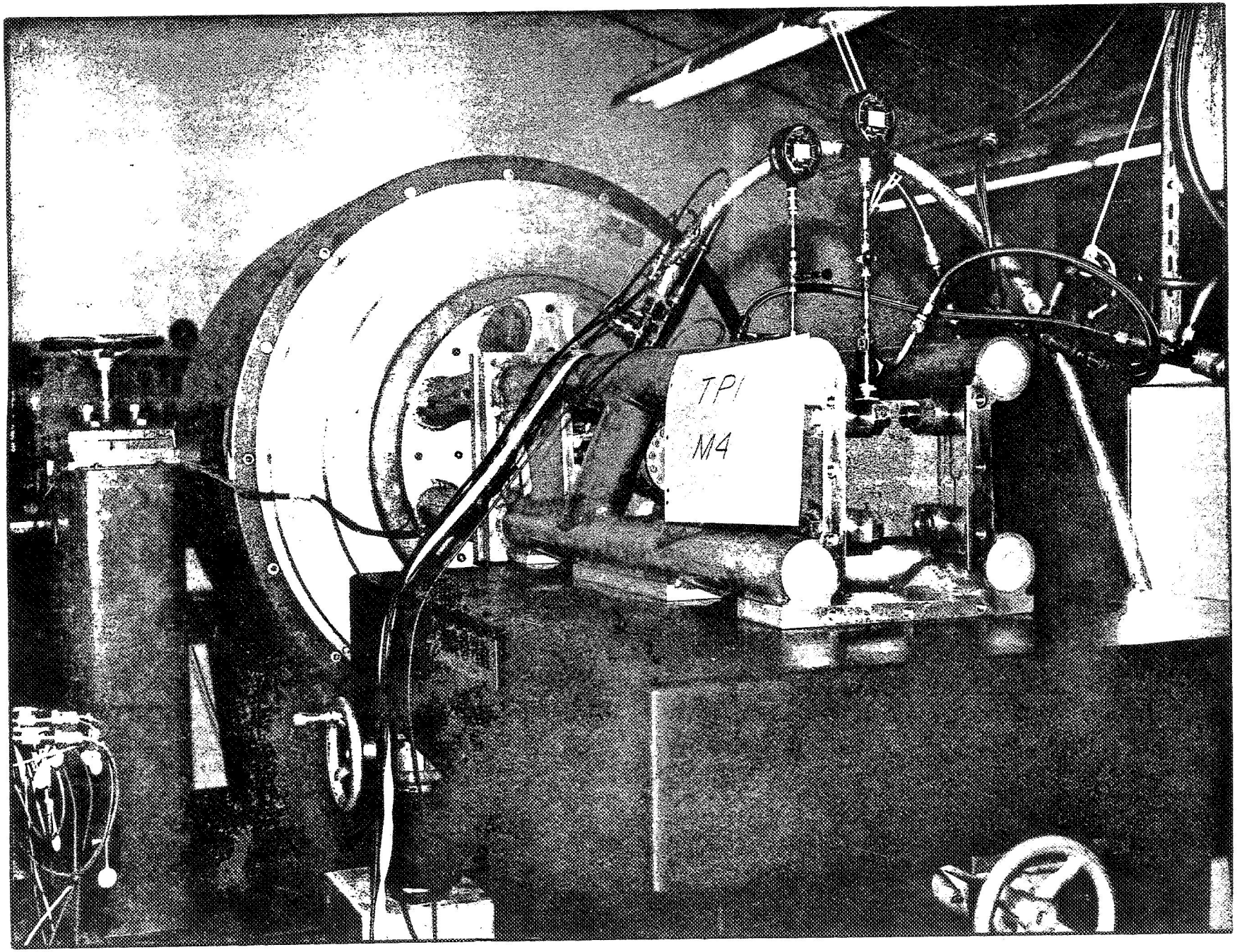


Figure 11. High-Temperature Vibration Test, Thrust Axis

2.2.3.2 (Continued)

was adjusted to yield an actuator cylinder differential pressure of 1,200 psid. A cycling frequency of 0.35 cps was used instead of the required 1.0 cps. The lower frequency was required because the hydraulic pumping unit could not provide sufficient fluid flow at 1.0 cps. This resulted in less noise and less movement of the axial load mechanism. Having established the temperature and load conditions, the sinusoidal and random vibration tests were performed according to the procedures described in paragraph 2.2.2.2.

Periodically during the vibration runs, the triangular input was reduced to zero and the actuator piston was commanded by manual control to the full extend and full retract positions. This procedure was performed in an effort to excite the high-frequency amplifier/valve noise. Cylinder fluid temperature, cylinder differential pressure, supply and return pressures, telemetry feedback (element No. 2), position feedback (element No. 1), and valve input-current performance data were obtained. Structural data were obtained from accelerometers located as shown in figure 12. Hydraulic-fluid samples were taken before the initial hookup of the hydraulic lines and after completion of the vibration testing. Photographs of the test specimen in the load support fixture are presented in figures 2-8 and 2-9.

2.2.3.3 Results

Sinusoidal and random vibration tests were successfully completed in the radial, tangential, and thrust directions. The resulting data indicated normal actuator performance throughout the series of tests. Piston cyclic motion was continuous and uninterrupted. The amplifier/valve noise

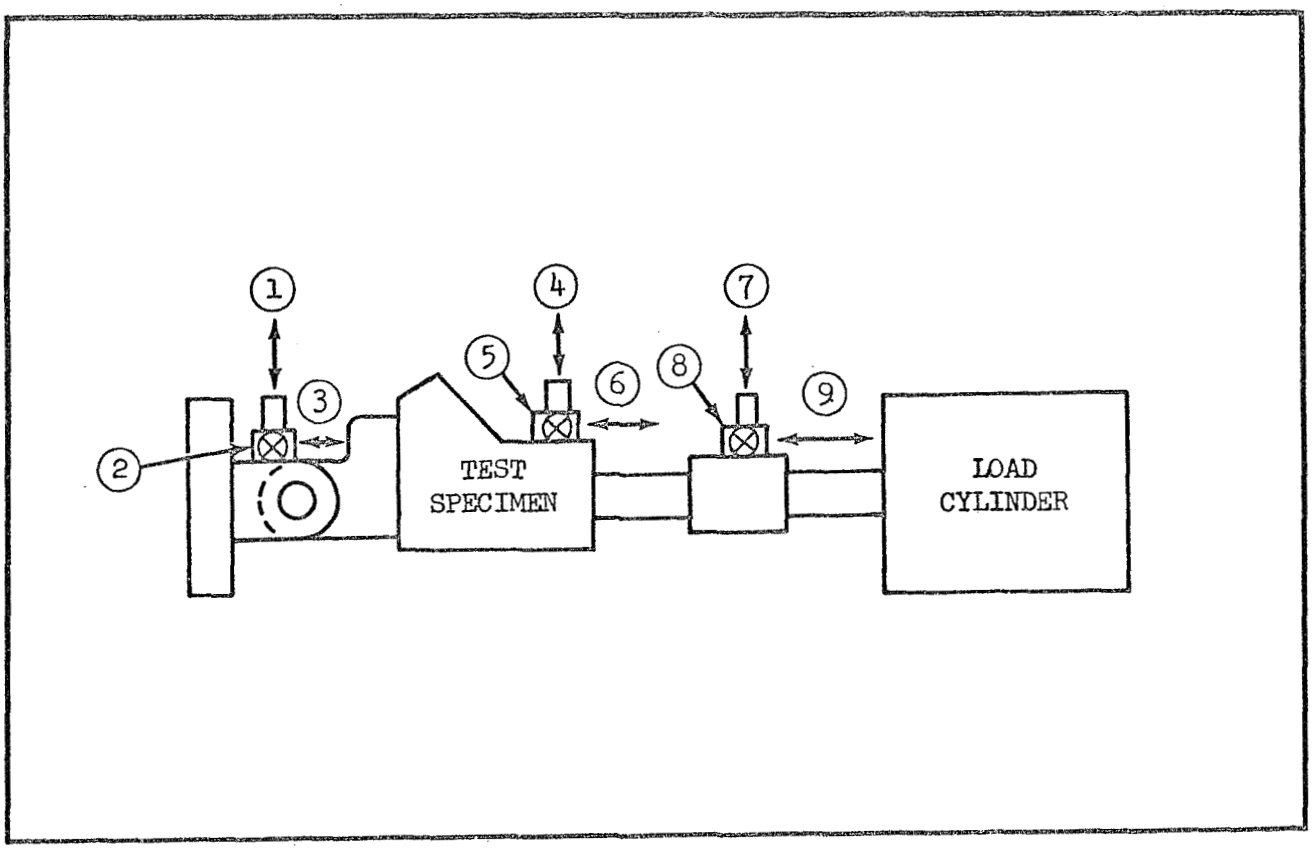


Figure 12. Accelerometer Locations, High-Temperature Vibration Test

problem did not reveal itself under conditions of high temperature, vibration, and axial load. Using the NASA flight amplifier, the measured noise at the valve coil was steady at approximately 7 ma amplitude in the very high radio-frequency band. No low-frequency noise was observed.

The post-vibration frequency response test revealed an increase in load/current resonant peaking; see chart 3-17 and Table 4-11. This implied a reduction in servo system dynamic damping. The DP-F piston and springs were removed from the actuator housing and examined. The piston was free in its bore, and the springs appeared normal with measured rates of 450 to 500 pounds per inch. It was suspected that the change in damping was possibly caused by shifting of the DP-F nozzles. For this reason, the

2.2.3.3 (Continued)

actuator was returned to Moog Servocontrols, Inc., for additional analysis. Since the increased load/current resonant peaking was only slightly higher than the allowable limits, the results of the high-temperature vibration test were considered acceptable without additional frequency response testing.

2.2.4 Acceleration

2.2.4.1 Requirements

There shall be no evidence of damage, failure, or maladjustment when the actuator assembly is subjected to a sustained acceleration of 8 g for 3 minutes in the vehicle longitudinal direction and an acceleration of 2 g for 12 minutes in each direction of the two mutually perpendicular axes (48-minutes total). The acceleration tests shall be performed with 3,650-psig hydraulic pressure applied to the actuator, and with the actuator piston cycling at 0.5 cps and ±1-inch piston amplitude. Upon completion of the acceleration test, the actuator shall meet the production frequency response test requirements.

2.2.4.2 Procedure

The test specimen was mounted in the actuator acceleration test fixture and oriented on the centrifuge test section for the first acceleration run. See figure 13. A television camera was located above the test

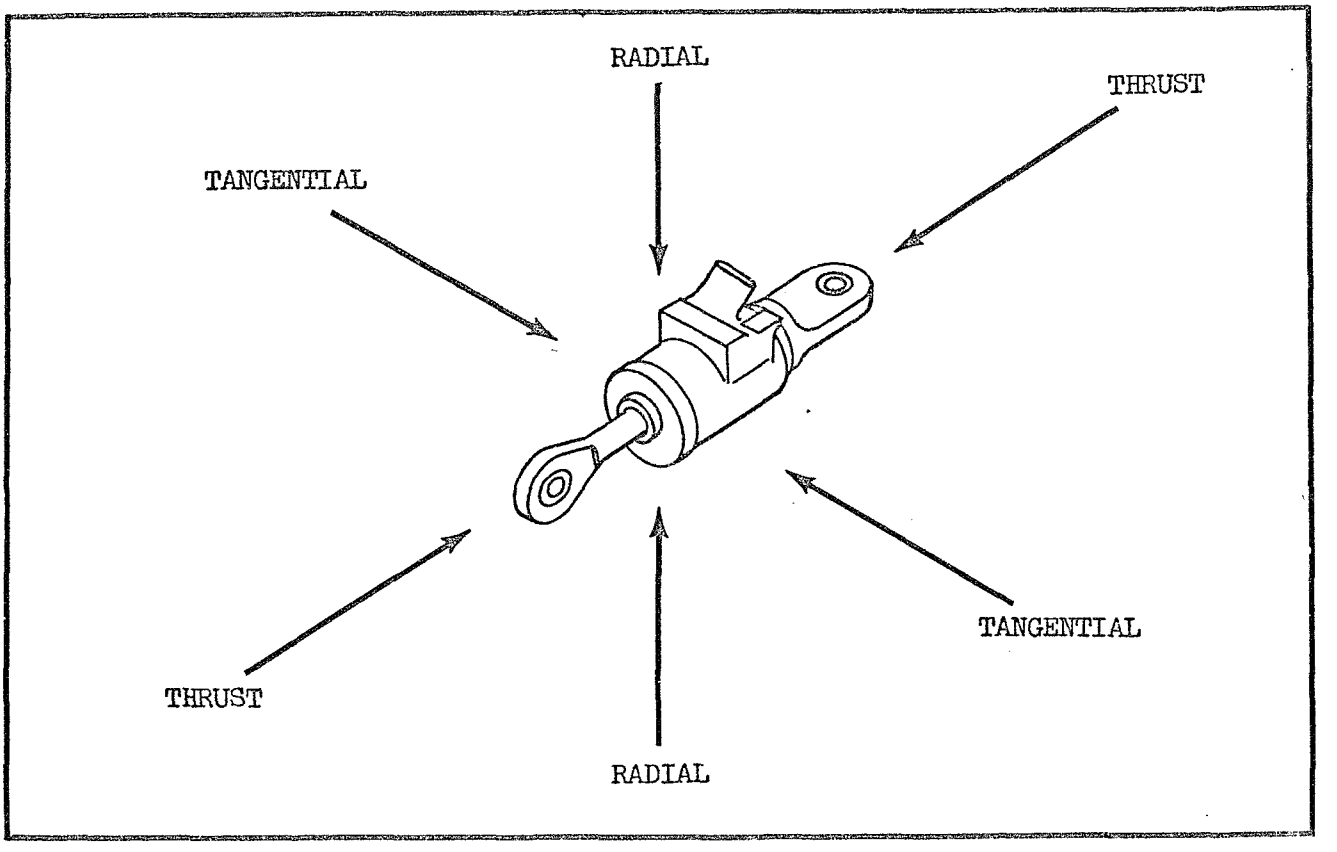


Figure 13. Directions of Applied Acceleration

section for observing the test specimen during the test. The test fixture, shown in figures 14, 15, and 16, could be rotated to allow application of the acceleration force in the six principal actuator directions. The tail end of the actuator was pinned to the fixture structure and the piston end was attached to an unloaded pivot. This allowed unloaded actuator cycling.

The actuator cylinder differential-pressure transducer and temperature probe were installed and operational during the test. Outputs from the transducer and probe were monitored on an oscillograph. The primary purpose of monitoring these two channels was to note electrical circuit continuity during periods of sustained acceleration and deceleration. Valve input current and piston feedback position were also monitored.

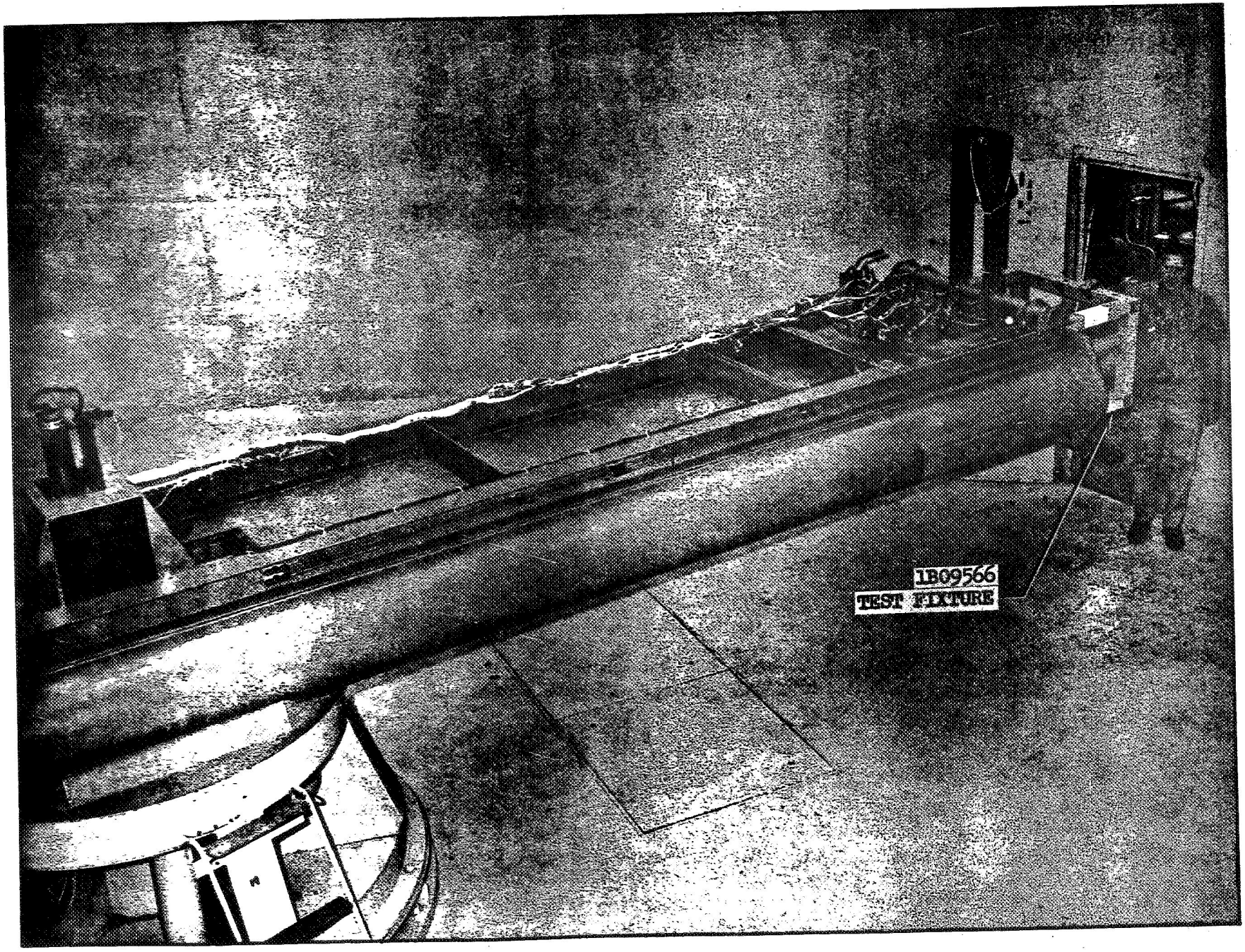


Figure 14. Acceleration Test Setup on Centrifuge

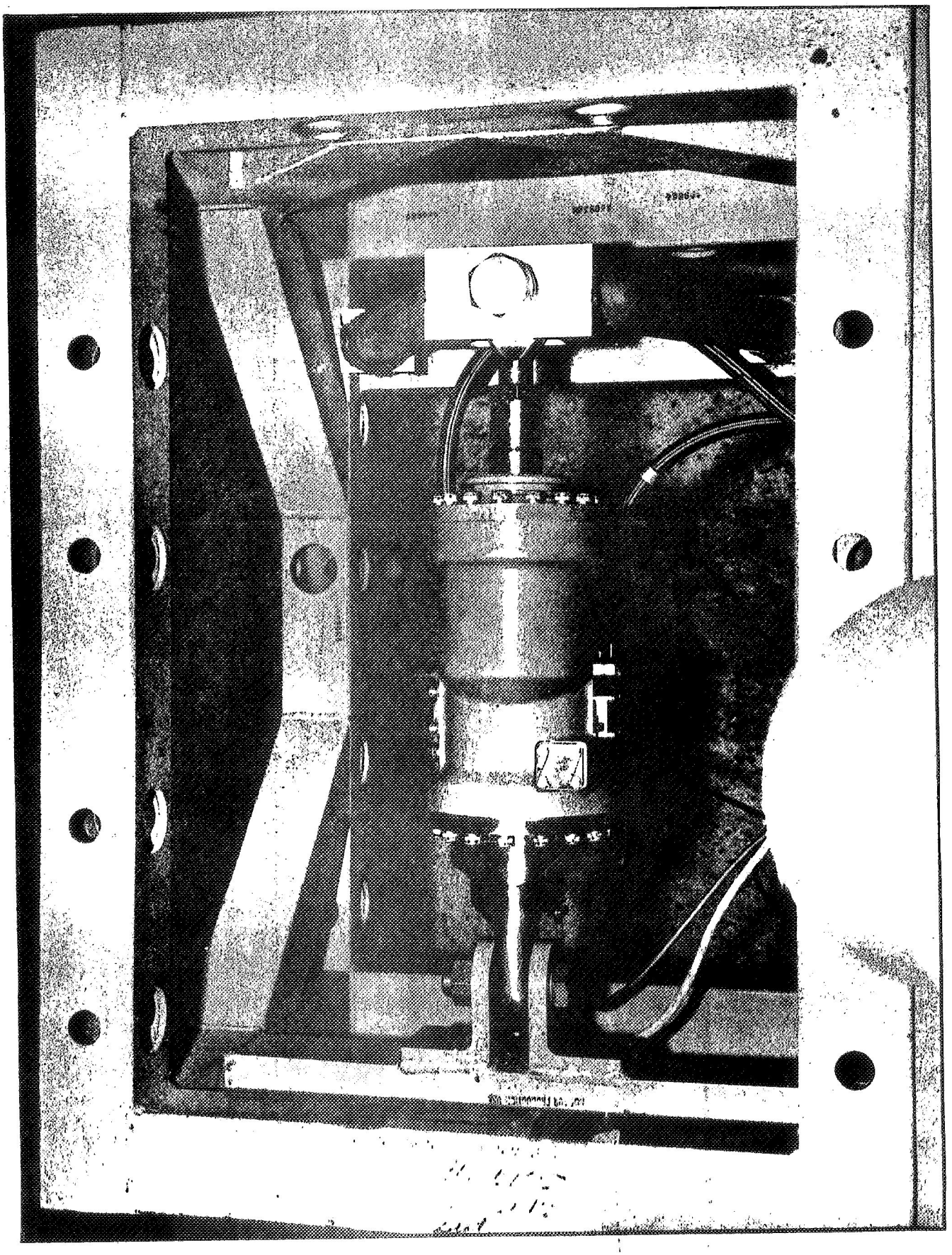


Figure 15. Actuator Mounted in Acceleration Fixture, View 1

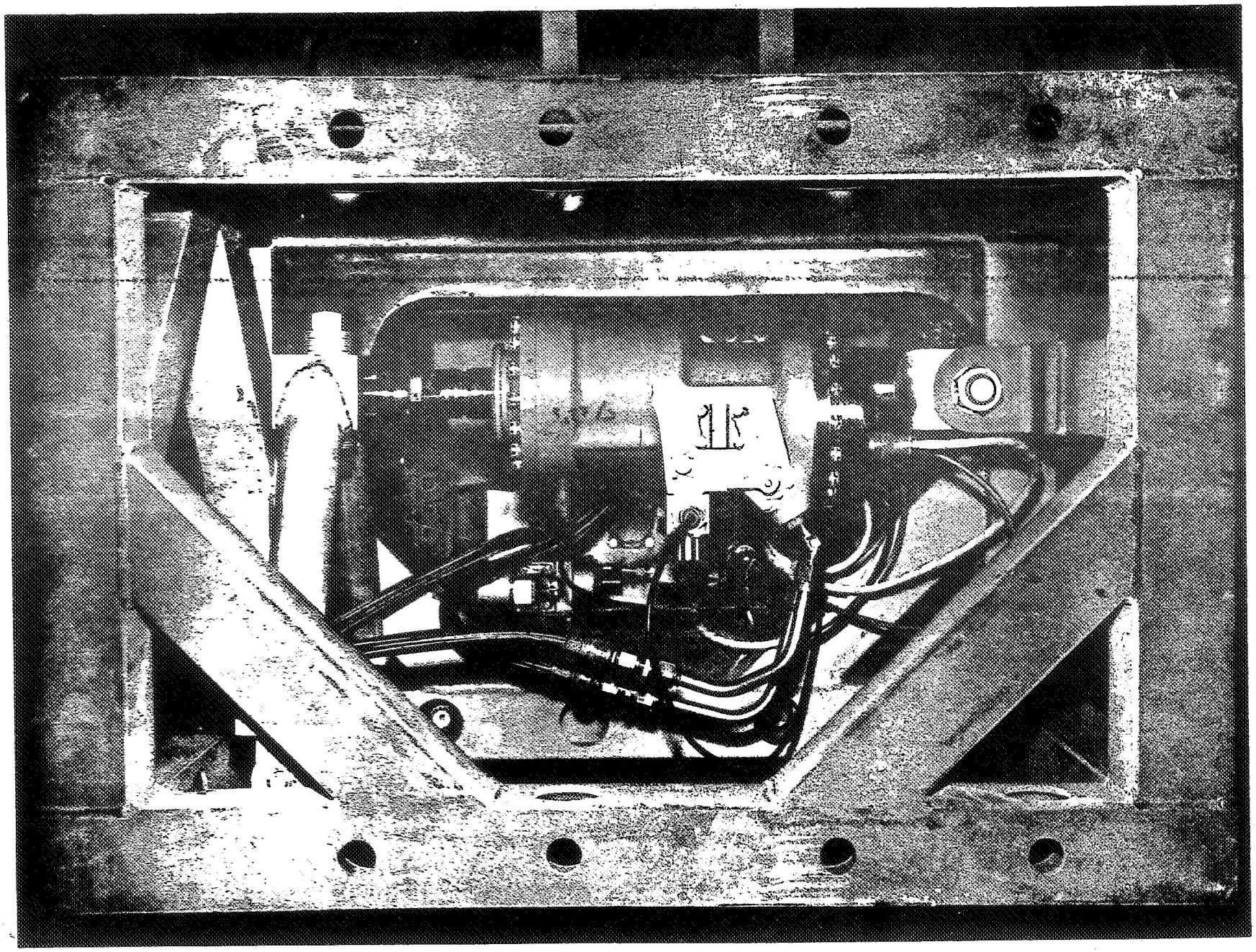


Figure 16. Actuator Mounted in Acceleration Fixture, View 2

2.2.4.2 (Continued)

Hydraulic power was supplied by a pumping system integral with the centrifuge system. Hydraulic fluid was applied to the actuator at 3,650 psig supply pressure and 100° ±10° F temperature during the test runs. The actuator was cycled continuously at 0.5 cps and ±1-inch piston amplitude while subjected to a sustained acceleration of 8 g for 3 minutes in the vehicle longitudinal direction and an acceleration of 2 g for 12 minutes in each direction of the two mutually perpendicular axes. A total of six acceleration runs were made.

2.2.4.3 Results

Table 6 lists the acceleration test sequence and test parameters. Table 6 shows the different servo inputs from the required 0.5 cps ±1 inch. The parameter was not significant in the acceleration test, and, consequently, was changed to accommodate the flow capability of the pumping system. Test specimen No. 3 performed satisfactorily at the applied accelerations in all six directions with no evidence that the servo or the instrumentation channels were adversely affected by the applied acceleration. There was

TABLE 6. ACCELERATION TEST SEQUENCE AND PARAMETERS, TEST SPECIMEN NO. 3

RUN NO.	PLANE	SERVO INPUT	ACCELERATION
1	Thrust	0.2 cps ±0.9 in.	8 g for 3 min.
2	Tangential	0.3 cps ±0.9 in.	2 g for 12 min.
3	Tangential	0.3 cps ±0.9 in.	2 g for 12 min.
4	Thrust	0.3 cps ±0.9 in.	8 g for 3 min.
5	Radial	0.3 cps ±0.9 in.	2 g for 12 min.
6	Radial	0.3 cps ±0.9 in.	2 g for 12 min.

2.2.4.3 (Continued)

no evidence of erratic servo response or piston null shift. Output signals from the temperature probe and differential-pressure transducer were continuous and normal. The post-acceleration frequency response indicated that the dynamic response of the actuator was within production acceptance test tolerances as shown in chart 3-18.

2.2.5 Mechanical Shock

2.2.5.1 Requirements

There shall be no evidence of damage, malfunction, or performance degradation when the actuator assembly is subjected to three shocks in one direction along each of three mutually perpendicular axes, a total of nine shocks. The shock inputs shall be 100.0-g peak (half-sine pulse) with a duration of 10±2 milliseconds.

2.2.5.2 Procedure

Test specimen No. 3 was installed in the actuator holding fixture which in turn was mounted on the test plate of the pressure-actuated shock tester. Figures 17, 18, and 19 show the test setup for the radial, tangential, and thrust axes, respectively. The actuator holding fixture, used in the vibration test, was modified for use in the shock test. The shock tester is gas-actuated and propels the test specimen vertically upward. Vertical guide poles at either end of the test plate

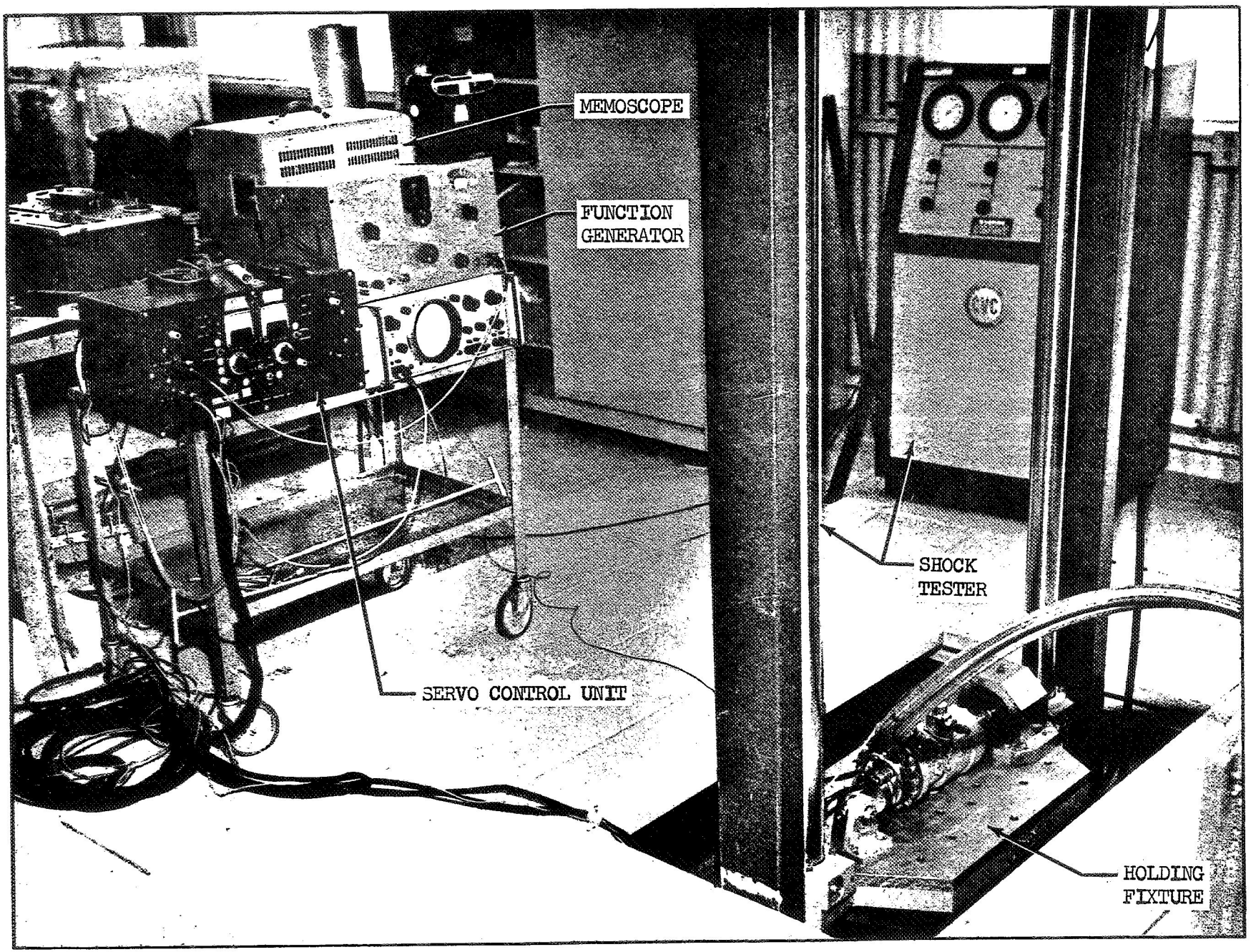


Figure 17. Mechanical Shock Test Setup, Radial Axis

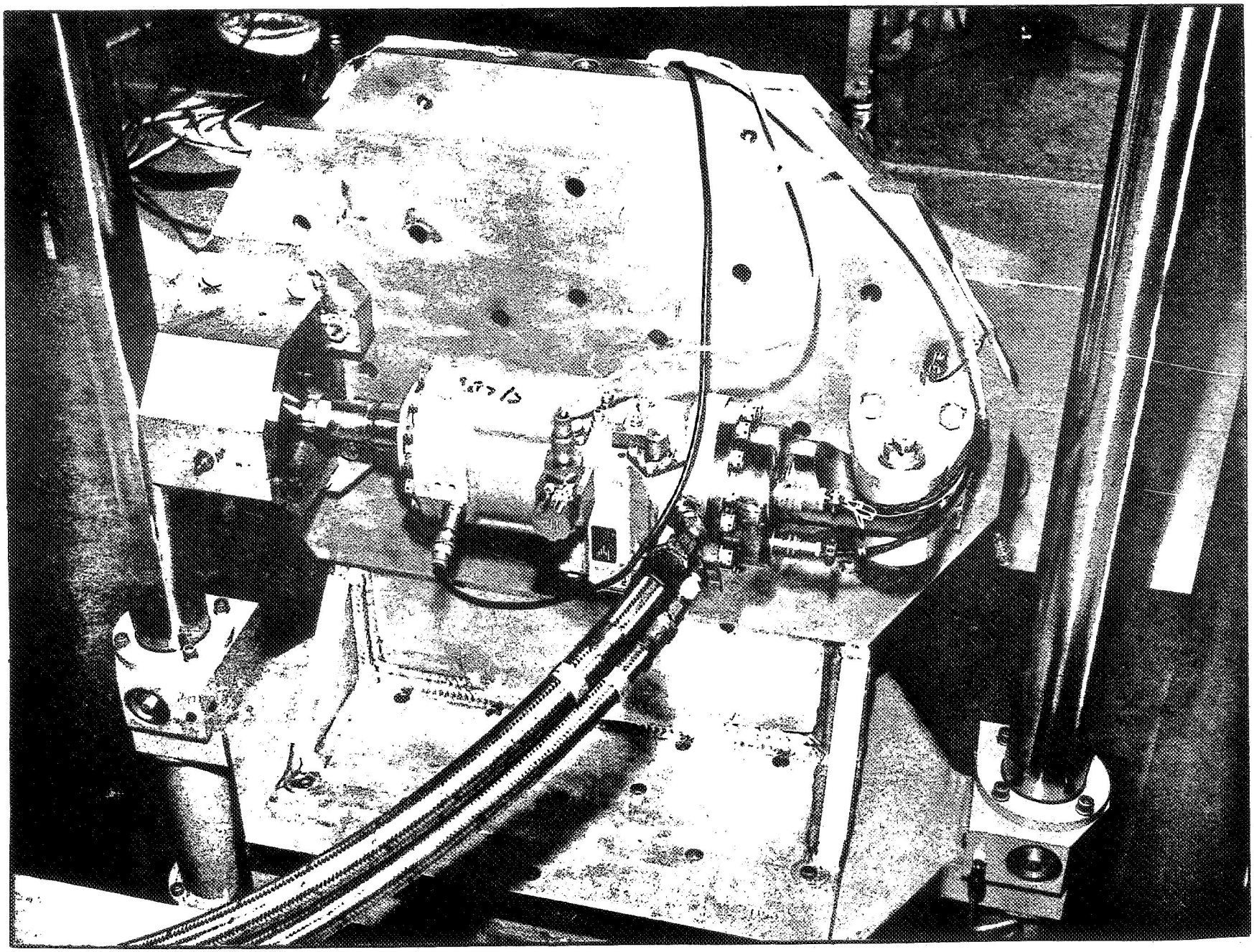


Figure 18. Mechanical Shock Test Setup, Tangential Axis

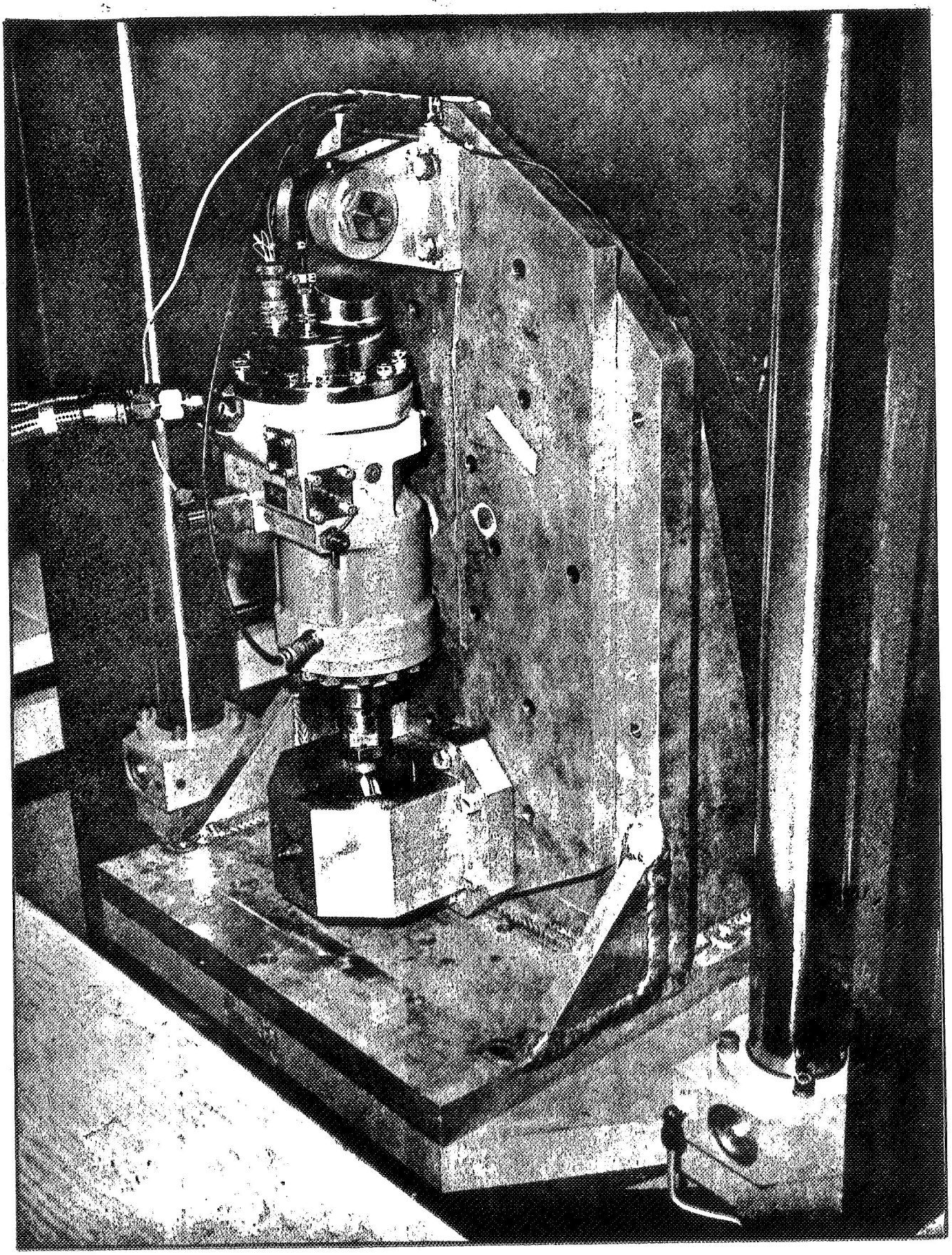


Figure 19. Mechanical Shock Test Setup, Thrust Axis

2.2.5.2 (Continued)

restrict travel to the vertical direction and are also part of the braking system. The type and duration of shock impulse are controlled by the type of orifice installed in the actuating mechanism. Pulse amplitude is a function of the gas supply pressure.

The test specimen was operational during shock testing, with 3,650-psig hydraulic supply pressure at 100°F. Return hydraulic pressure was 50 to 60 psig. The input shock impulse was measured with an oscilloscope and each scope trace was photographed. The control accelerometer for each of the three axes was near the base of the test-section tail-end bracket. Table 7 shows the test dates, sequence of testing, and test input parameters.

TABLE 7. MECHANICAL SHOCK TESTS, TEST SPECIMEN NO. 3

SHOCK	DATE	DIRECTION OF APPLIED SHOCK	MAGNITUDE OF INPUT SHOCK PULSE (g)	ACTUATOR COMMAND INPUT
1	4 May 1965	Radial	85	0.2 cps at ±30 ma
2	4 May 1965	Radial	80	0.2 cps at ±30 ma
3	4 May 1965	Radial	80	0.2 cps at ±30 ma
4	5 May 1965	Thrust	75	0.2 cps at ±30 ma
5	5 May 1965	Thrust	75	No Input
6	5 May 1965	Thrust	75	No Input
7	5 May 1965	Tangential	70	0.2 cps at ±30 ma
8	5 May 1965	Tangential	70	No Input
9	5 May 1965	Tangential	70	0.2 cps at ±30 ma

2.2.5.3 Results

Test specimen No. 3 was shock-tested per the requirements of paragraph 2.2.5.1. The magnitudes of the input shock pulses during the test were 20 to 30 per cent lower than the 100 g specified; this difference was caused by the low-volume pressure capacity of the shock-tester gas supply. Based on the extensive vibration testing performed on specimen No. 3, it was decided that the lower levels were acceptable.

A command of 0.2 cps at ±30 ma was applied to the actuator during most of the shock tests. For three tests, however, no actuator command was applied. No difference in actuator response was observed for the two methods.

Valve current and piston feedback were monitored on an oscillograph, along with the actuator temperature probe and differential-pressure transducer. A reaction to the shock impulse was not discernable on any of the traces except the differential-pressure trace, where a small sharp excursion (possibly wiper bounce of the potentiometer element) occured at the application of the shock, followed by immediate recovery of the trace to the original position.

During shock tests in the thrust direction, small amplitude oscillations were observed on the current trace after the application of the shock. The frequency of the oscillations measured approximately 225 cps. Removal of the electrical connector from the actuator stopped the oscillation. When another servo amplifier was used, the oscillations did not occur. The exact reason for the oscillations is not known but they are believed to have been caused by a faulty component in the dual-channel servo controller, not by the actuator.

2.2.5.3 (Continued)

The required shock tests were completed satisfactorily, with no evidence of damage, malfunction, or performance degradation to the actuator. The post-shock frequency response test revealed that dynamic response (load/command) was still within production tolerance for the 1/2-degree input. See charts 3-19 and 3-20 and Table 4-12.

2.2.6 Thermal Vacuum

2.2.6.1 Requirements

There shall be no evidence of leakage, malfunction, or performance degradation when the actuator assembly is subjected to a vacuum of 10^{-7} Torr in a temperature of -300°F while simulating ground hold and missile flight conditions.

2.2.6.2 Procedures

2.2.6.2.1 Pretest Conditioning

Actuator test specimen No. 2 was mounted on a support fixture, suspended from the lid of the vacuum chamber, as shown in figures 20 through 23. One end of the fixture was pivoted to permit actuator cycling. The supports at each end of the actuator contained heat sinks for temperature control, simulating the temperature conductance path from vehicle cold

Figure 20. Thermal-Vacuum Test Setup

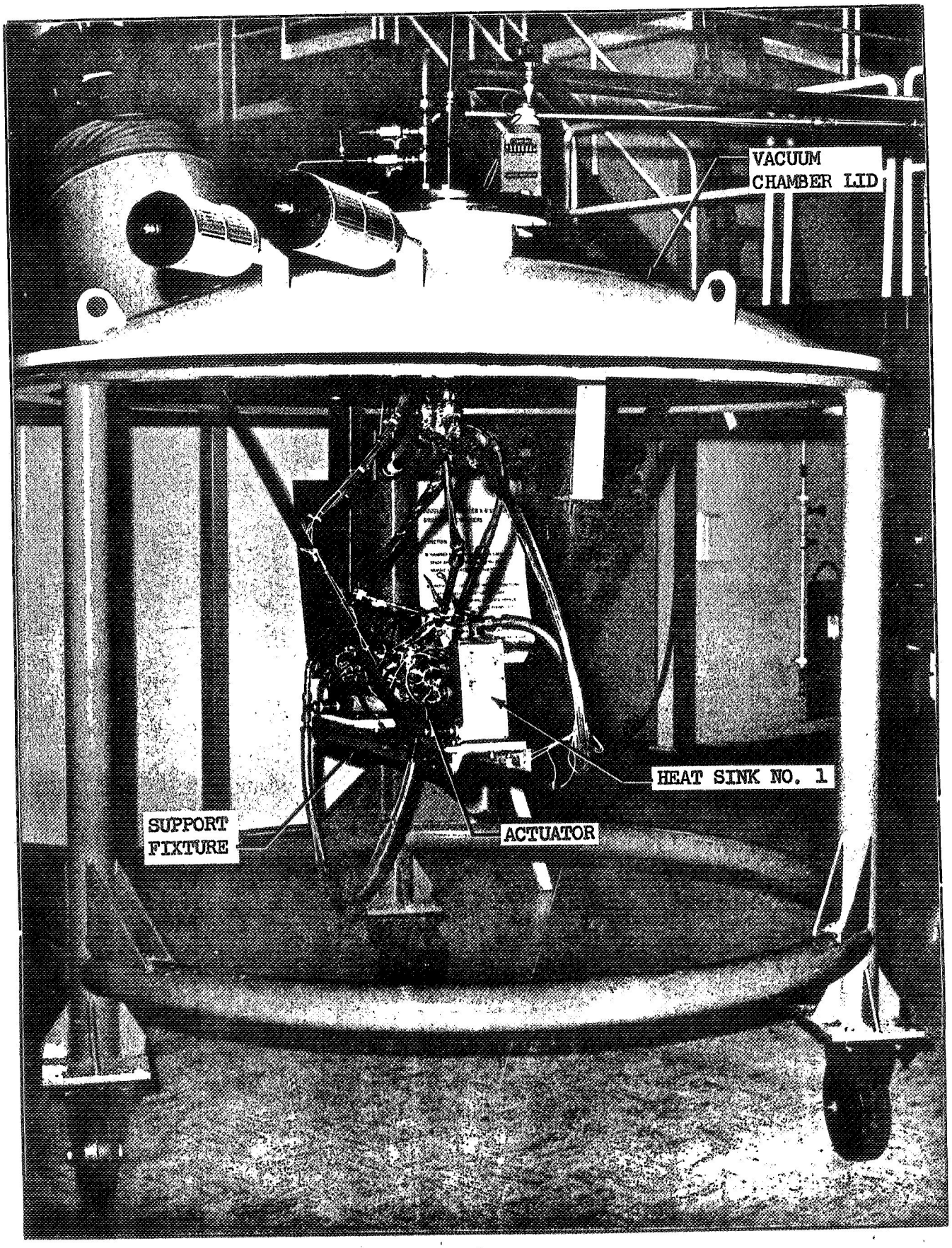


Figure 21. Actuator Assembly Suspended from Vacuum Chamber Lid

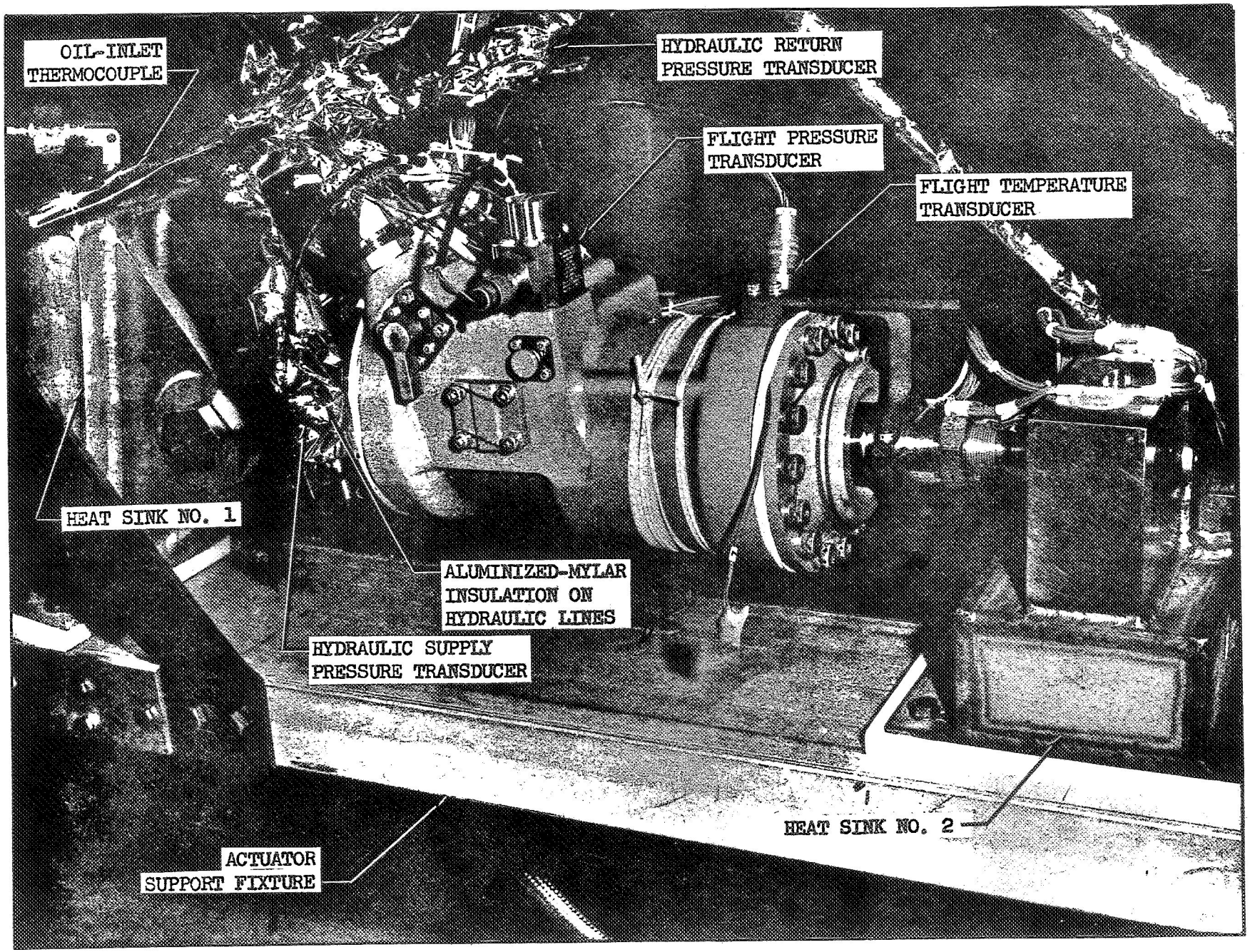


Figure 22. Actuator Assembly Mounted in Support Fixture

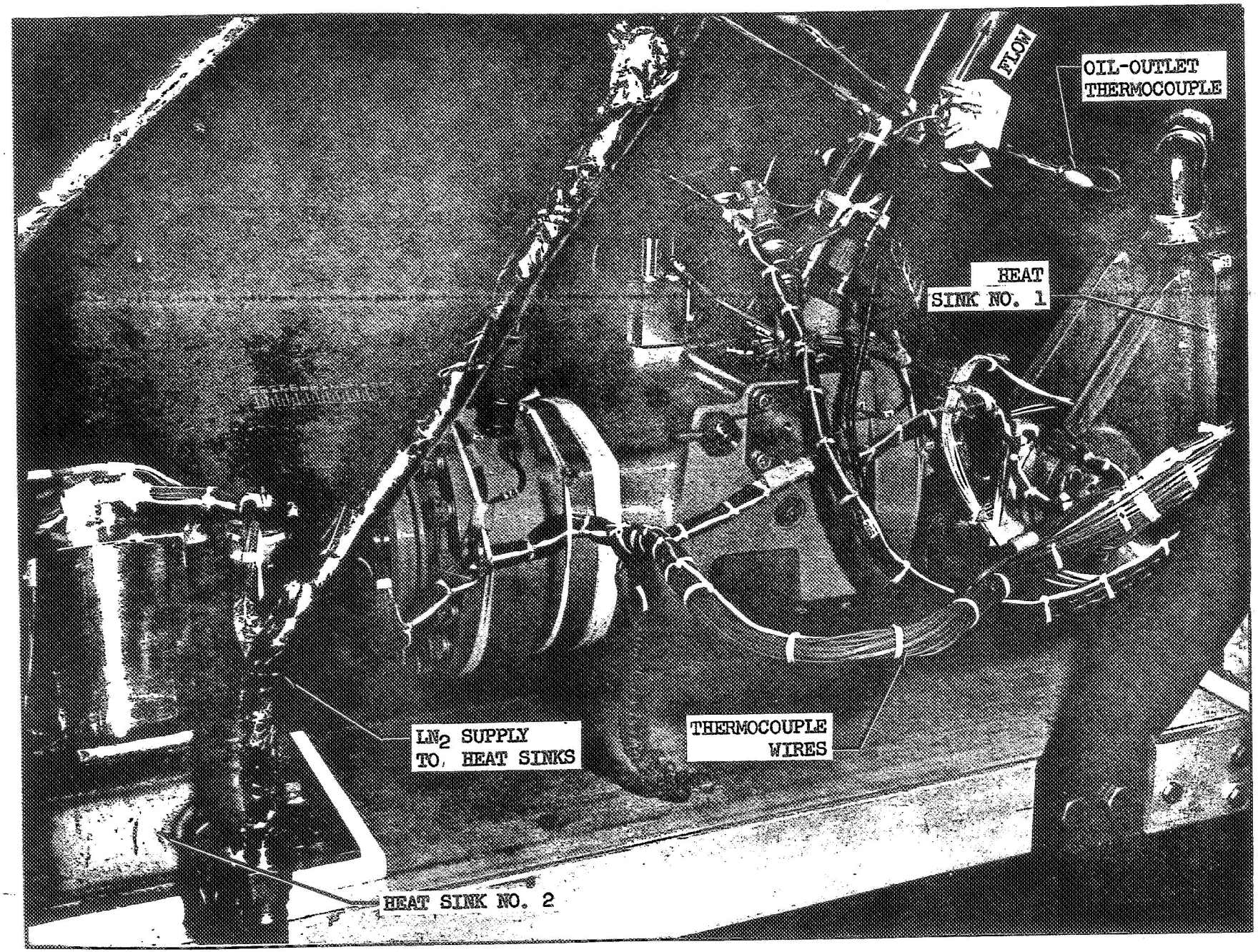


Figure 23. Actuator Instrumentation, Right Side

2.2.6.2.1 (Continued)

surfaces to the hydraulic actuator. Thermocouples were placed on the heat sinks, on the actuator body, and in the hydraulic-fluid inlet and outlet lines to the actuator. Thermocouple locations are shown schematically in figure 24. Figure 25 provides a schematic diagram of the thermal-vacuum test hydraulic circuit. Additional photographs of the test setup and equipment are presented in Appendix 2, figures 2-10 through 2-13.

During a pretest conditioning period, the test specimen was conditioned to anticipate ground-hold temperature constraints, consisting of vacuum-chamber wall temperature at -300°F, hydraulic fluid in the hydraulic-cart reservoir at +100°F, supporting heat sinks at -100°±5°F applied for a minimum of 30 minutes before starting the simulated-launch operation, and vacuum-chamber pressure at 1×10^{-7} Torr during the conditioning period and throughout the test.

The actuator hydraulic inlet and return lines, as well as the pressure and temperature transducers, were insulated with aluminized mylar to preclude the possibility of aborting the test by freezing any system component not part of the test specimen. This also minimized the heat transfer of the hydraulic lines and pressure transducers by conduction from the test specimen, since these items were not flight configuration.

2.2.6.2.2 Test Summary

After stabilization of the pretest conditions, an S-IVB flight program was simulated to determine the temperature transients throughout the

THERMOCOUPLE IDENTIFICATIONS

NUMBER	LOCATION	NUMBER	LOCATION
1	ACTUATOR FIXED END, NEAR BEARING	10	BEARING, ROD END
2	ELECTRICAL CONNECTOR	12	OIL RETURN FROM ACTUATOR
3	PISTON DIFFERENTIAL PRESSURE FEEDBACK	13	OIL INLET TO ACTUATOR
4	ACTUATOR BODY (FILTER)	14	ACTUATOR BODY, NEAR FLANGE (ROD END)
5	NEAR PRESSURE FLIGHT TRANSDUCER	15	HEAT SINK NO.1 (ALUMINUM)
6	ACTUATOR BODY (CENTER)	16	HEAT SINK NO.2 (STAINLESS STEEL)
7	180 DEGREES FROM FLIGHT TEMPERATURE PROBE	17	THERMAL VACUUM CHAMBER WALL
8	PISTON ROD, NEAR BEARING	21	FLIGHT OIL TEMPERATURE TRANSDUCER
9	PISTON ROD, ON LOCKNUT		

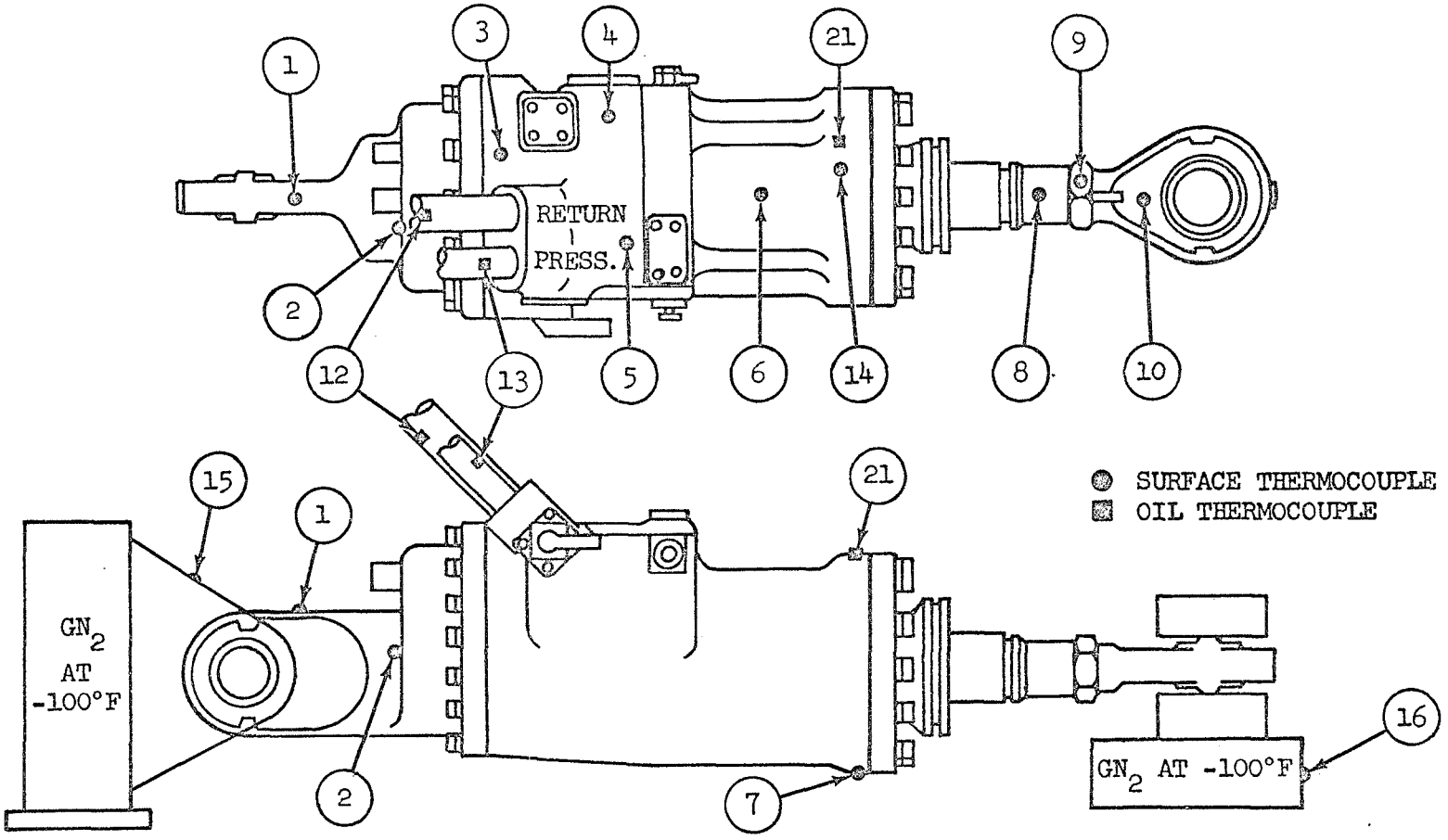


Figure 24. Thermocouple Locations, Thermal-Vacuum Test

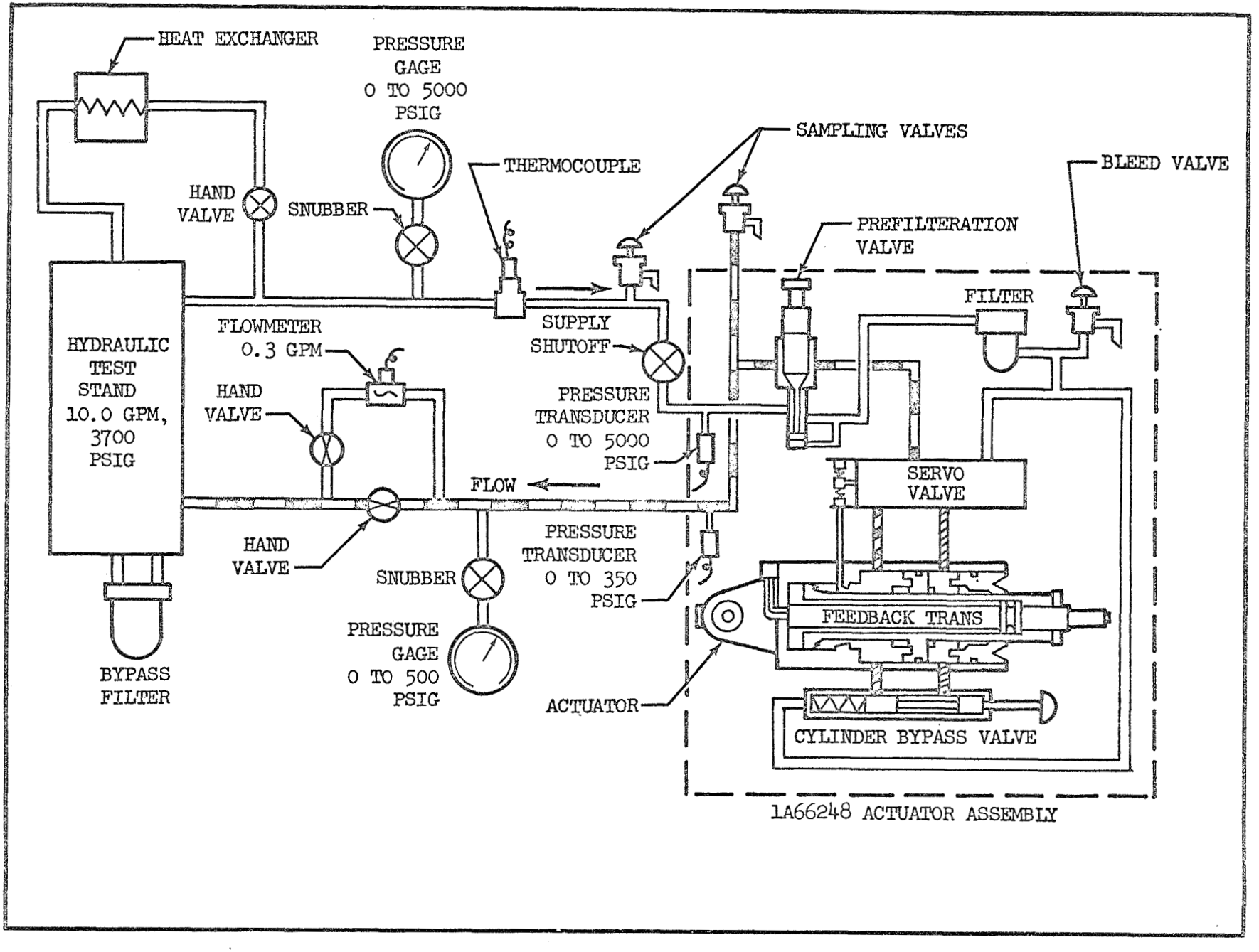


Figure 25. Thermal-Vacuum Test Hydraulic Circuit, Schematic Diagram

2.2.6.2.2 (Continued)

hydraulic actuator assembly, the effect of the thermal-vacuum environment on the operation of the actuator, the possible degradation of actuator seals which could result in hydraulic fluid leakage, and the temperature transients during an extended 4 1/4 hour hydraulic-fluid stagnation period (auxiliary pump turned off).

Three tests were conducted. Tests 1 and 2 were identical tests performed to simulate the flight mode of the vehicle by simulating the anticipated hydraulic fluid-flow and pressure conditions. Test 3 was a 4 1/2-hour temperature-decay test, preceded by a 2 1/2-minute simulated launch and followed by an engine restart and 5 1/2-minute simulated hydraulic system operation. The test procedures are outlined in Table 8.

2.2.6.2.3 Tests 1 and 2

Upon stabilization of the test constraints listed in paragraph 2.2.6.2.1, a simulated launch was initiated by applying 3,650-psig hydraulic inlet pressure to the actuator while maintaining 170-psig hydraulic return pressure with hand-valve control. The actuator was cycled for 2 1/2 minutes at 1/8 stroke and 0.5 cps, using the dual-channel servo controller. The third, fifth, and seventh columns in Table 8 represent periods when the hydraulic fluid was stagnated. The fourth and sixth columns represent auxiliary-pump operations at the indicated hydraulic pressures and flow rates. The external hydraulic reservoir supply was conditioned to +60°F and maintained at this temperature during the 5- and 8-minute auxiliary-pump operations. The eighth column represents a simulated engine restart

TABLE 8. THERMAL-VACUUM TEST SEQUENCE, TEST SPECIMEN NO. 2

TESTS 1 AND 2	← TEST DURATION →						
PRETEST CONDITIONING	SIMULATED LAUNCH (2 1/2 MINUTES)	HOLD (2 HOURS, 22 MINUTES)	SIMULATED AUX. PUMP OPERATION (5 MINUTES)	HOLD (52 MINUTES)	SIMULATED AUX. PUMP OPERATION (8 MINUTES)	HOLD (1 HOUR)	ENGINE RESTART (5 1/2 MINUTES)
Vacuum chamber at -300°F, 1x10-7 Torr Hydraulic fluid at -100°F Heat sinks at -100°±5°F, 30 minutes before, starting, and during test	Cycle at 1/8 stroke and 0.5 cps 3,650-psig hydraulic inlet pressure 170-psig hydraulic return pressure Reservoir fluid maintained at +100°F	No flow and no pressure	0.3 gpm 3,650-psig hydraulic inlet pressure 170-psig hydraulic return pressure Reservoir fluid maintained at +100°F	No flow and no pressure	0.3 gpm 3,650-psig hydraulic inlet pressure 170-psig hydraulic return pressure Reservoir fluid maintained at +100°F	No flow and no pressure	Cycle at 1/8 stroke and 0.5 cps 3,650-psig hydraulic inlet pressure 170-psig hydraulic return pressure Reservoir fluid maintained at +100°F
Data Sample Time — Digital Recorder ← as → Directed	Start and at 30 seconds for 2 1/2 minutes	Start and at 60 seconds for 12 minutes, then at 10 minutes	Start and at 60 seconds	Start and at 60 seconds for 12 minutes, then at 10 minutes	Start and at 60 seconds	Start and at 60 seconds for 10 minutes, then at 10 minutes	Start and at 30 seconds, then at 60 seconds for 5 minutes
Oscillator — as → Directed	Oscillator ON	No oscillator	Oscillator ON	No oscillator	Oscillator ON	No oscillator	Oscillator ON
TEST 3							
Setup and data same as preceding	Setup and data same as preceding	← 4 1/2-hour temperature decay, no flow and no pressure → Digital Recorder - every 10 minutes Oscillator - no data					Setup and data same as preceding

2.2.6.2.3 (Continued)

and 5 1/2-minute operation, with the same conditions as the initial engine operation in the second column.

2.2.6.2.4 Test 3

Test 3 was a 4 1/2-hour temperature-decay test, preceded by a 2 1/2-minute simulated hydraulic launch operation and followed by a simulated engine restart and 5 1/2-minute hydraulic system operation. Data samples were taken at the intervals indicated in Table 8.

2.2.6.2.5 Periodic Checks

Before thermal-vacuum testing was started, a bench-mark operating check of the actuator assembly was conducted to establish that the unit was functioning properly and that no leaks were evident. After each of the three tests, the actuator was allowed to stabilize to ambient room conditions and was cycled for 5 minutes at 0.5 cps, with a variation of 1/8 to 3/4 stroke. During the cycling, the unit was observed for evidence of oil leakage or abnormal operation. Hydraulic-fluid samples were taken before each test, and after test 3, to determine the amount of fluid contamination.

2.2.6.3 Results

The results of the thermal vacuum test are presented in Tables 9 and 10. In the 5-minute checks following tests 1, 2, and 3, the actuator

TABLE 9. FLUID TEMPERATURES, TEST SPECIMEN NO. 2

TEST	FLOW PHASE MINUTES	FLOW RATE (GPM)	RESERVOIR FLUID TEMPERATURE (°F)	
			PLANNED	ACTUAL
1	2 1/2	0.86	100	100
	5	0.29	60	85 to 95
	8	0.29	60	80 to 93
	5 1/2	0.86	100	85 to 103
2	2 1/2	0.86	100	100
	5	0.29	60	60 to 77
	2	0.29	60	66 to 82
	5 1/2	0.86	100	102
3	2 1/2	0.9	100	100
	5	0.29		
	8	0.29		
	5 1/2	0.94	100	100

TABLE 10. HYDRAULIC FLUID CONTAMINATION (100 ML SAMPLE VOLUME), TEST SPECIMEN NO. 2

DATE	TEST NO.	SAMPLE PORT	PARTICLE SIZE (MICRONS) 10-25	26-50	51-100	101-700 (& FIBER)	OVER 700 (ALL FIBER)
5-5-5	Hyd. Cart	Supply	44	25	9	1	
		Return	9	10	1	1	
6-24-5	Hyd. Cart	Supply	21	5	1	3	
		Return	280	81	16	4	
7-2-5	Pre-1	Supply	28	12	7	2	
		Return	167	45	17	4	3
7-8-5	Pre-2	Supply	64	58	7	7	
		Return	17	18	9	6	
7-8-5	Pre-3	Supply	115	16	4	6	
		Return	311	51	0	3	
7-9-5	Post 3	Supply	224	100	21	10	0
		Return	293	34	7	4	1
MIL-H-5606 CLEANLINESS REQUIREMENT		Supply	2,150	530	60	10 (over 100)	
		Return	4,300	1,060	120	10 (over 100)	

2.2.6.3 (Continued)

assembly was operated at ambient room conditions to simulate its operation on the flight vehicle. No evidence of erratic or abnormal operation of the actuator nor any evidence of hydraulic leakage due to seal failure was noted. Evaluation of temperature data during simulated launch indicated that hydraulic-oil temperature decayed to a minimum of approximately +20°F at actuator inlet and outlet ports and also in the actuator at the flight temperature transducer. During extended-hold operation simulating a flight without operating the auxiliary pump, hydraulic-oil temperatures decayed to -8°F at the inlet and outlet ports and to 0°F at the flight-temperature transducer. Results of the actuator thermal-vacuum test were satisfactory.

As indicated in Table 8, hydraulic supply and return pressures were specified at a flow rate of 0.3 gpm. Since the pressure and flow conditions could not both be set for the test, the pressure conditions were set and the flow was monitored under these pressure conditions. This monitoring showed the resulting flow rate to be 0.29 gpm consistently.

Oil temperatures in tests 1 and 2 remained above +20°F in the inlet and outlet lines of the actuator, as did the oil inside the actuator. Test 3 was an extended cold-soak test in which the system was stagnated for 4 1/2 hours. Minimum oil temperature in the actuator was 0°F after 4 1/2 hours. Oil temperature in the inlet and outlet lines near the actuator reached 0°F after 3.9 hours, and a minimum of -8°F after 4 1/2 hours.

2.2.6.3 (Continued)

Table 10 shows the particle counts from the supply and return hydraulic fluid samples taken throughout the thermal-vacuum testing. Two preliminary samples were made to check the cleaning ability of the hydraulic cart. Additional samples were taken at the actuator inlet and outlet ports before each test and after test 3. The particle counts were compared with the equivalent cleanliness specifications in MIL-H-5606, shown at the bottom of Table 10, and were acceptable on that basis.

The post-thermal-vacuum frequency-response test revealed acceptable dynamic performance following the thermal-vacuum test. See charts 10 and 11 and Table 4-13.

2.2.7 Resistance to Heat Flow

2.2.7.1 Requirements

There shall be no evidence of malfunction or degradation when the actuator assembly is subjected to the following simulated-prelaunch temperature environment. Liquid nitrogen coolant shall be applied to the heat sinks of the actuator support fixture to maintain a heat-sink surface temperature of -175°F. With 3,650-psig hydraulic supply pressure applied to the actuator at a temperature between +10° and +40°F, and with a neutral command to the actuator, actuator temperature distribution shall be measured for environmental temperatures of -25°, -45° and -80°F.

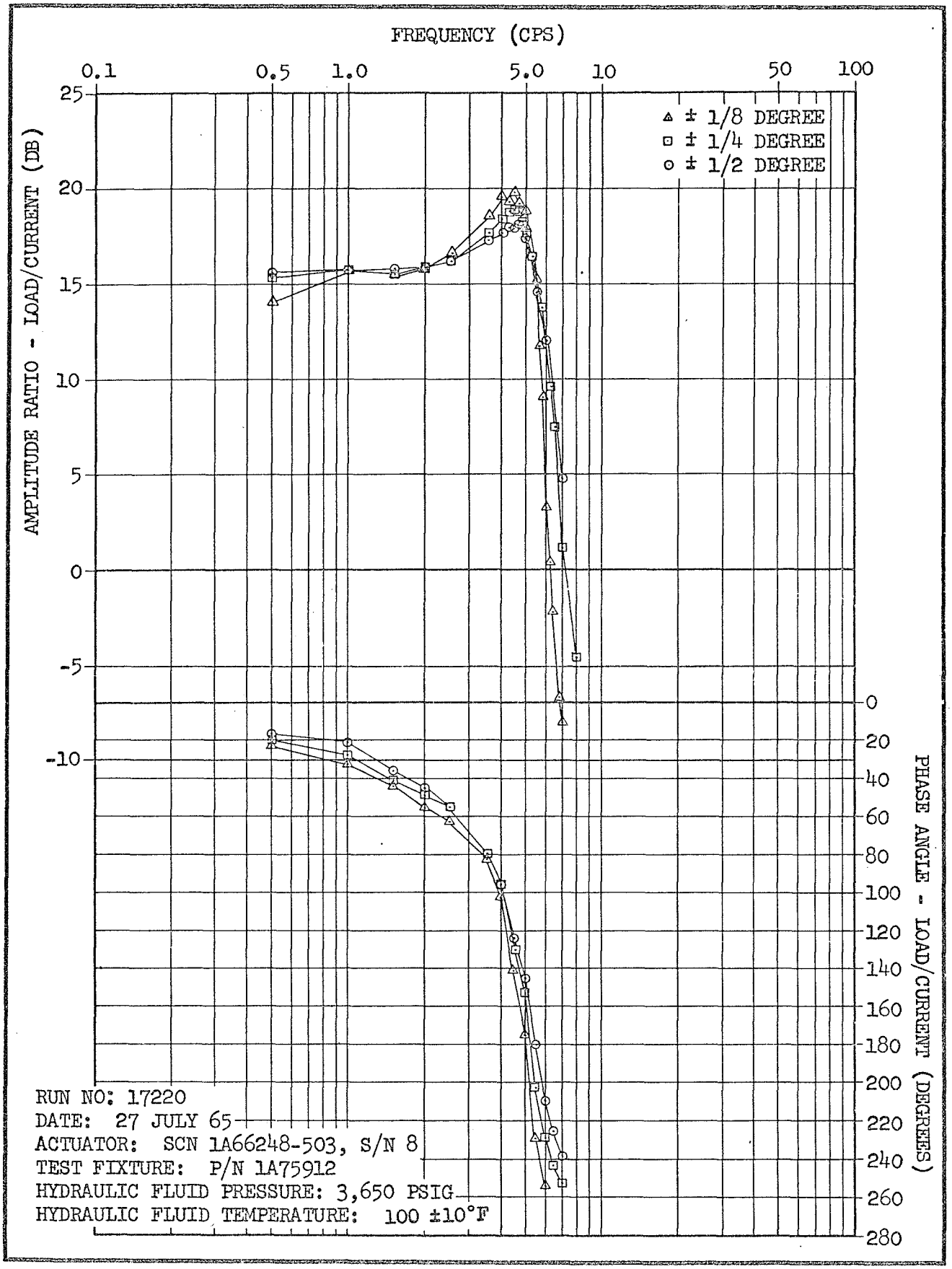


Chart 10. Post-Thermal-Vacuum Frequency Response, Load/Current - Test Specimen No. 2

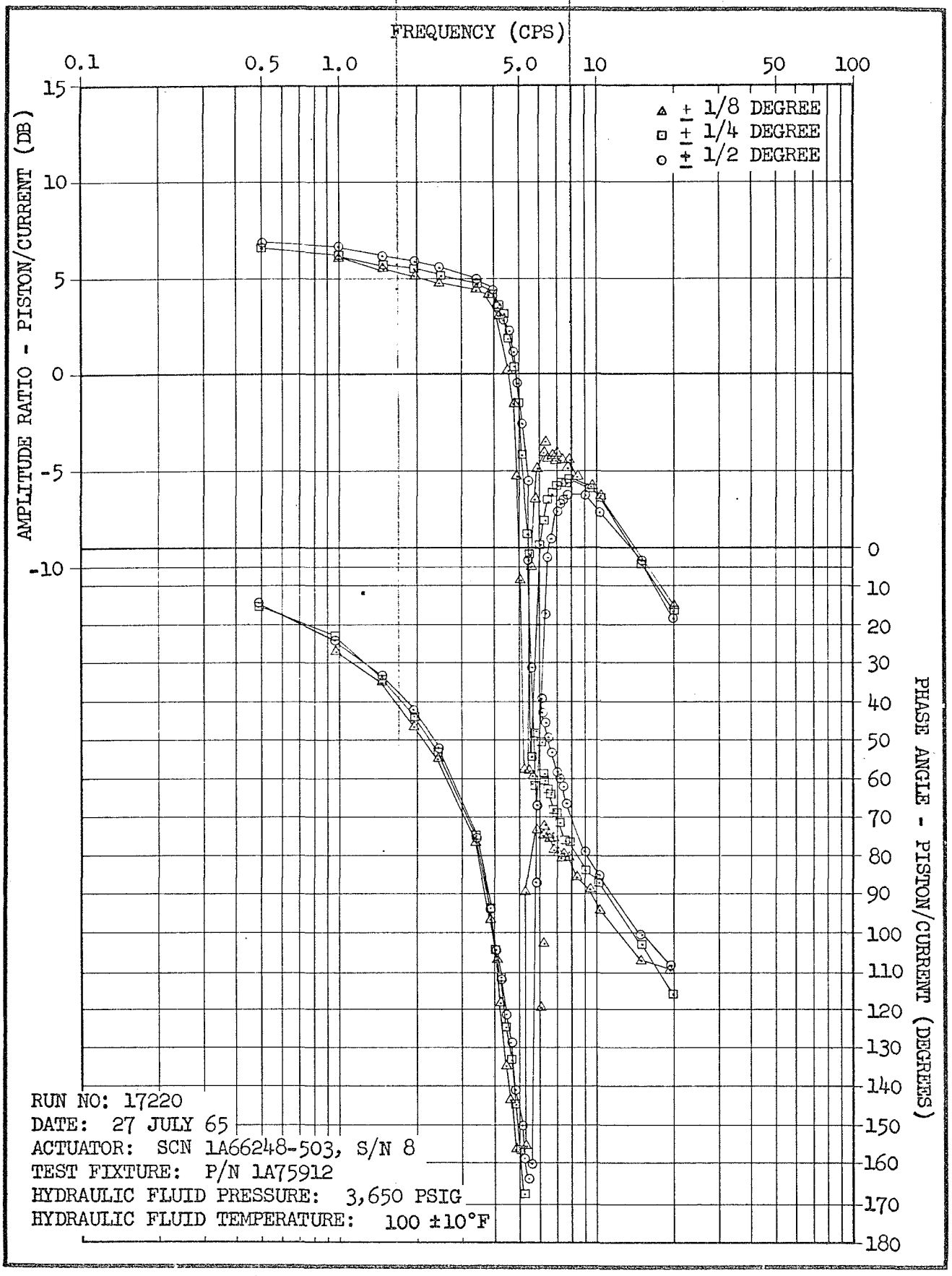


Chart 11. Post-Thermal-Vacuum Frequency Response, Piston/Current - Test Specimen No. 2

2.2.7.2 Procedure

The resistance-to-heat-flow test was a laboratory effort to simulate prelaunch thermal conditions which will be encountered by the actuator. The actuator was subjected to attach-point and environmental temperatures anticipated during countdown. Various actuator surface temperatures were monitored to establish temperature distributions similar to that encountered during the hydraulic system autocycle mode.

The actuator environmental holding fixture served as an actuator support and thermal simulator. The holding brackets of the fixture were manufactured from 6061-T651 aluminum and Type 327 corrosion-resistant steel to simulate the heat transfer characteristics of the vehicle structural support and engine attach point, respectively. The rectangular boxes attached to the brackets served as liquid-nitrogen coolant reservoirs. Chromel-constantan wire thermocouples were installed over the surface of the actuator and holding fixture as shown in figure 26. Thermocouple outputs were monitored by direct-readout temperature recorders.

Figure 27 shows the installation of the actuator and test fixture in the test chamber with hydraulic and liquid-nitrogen lines attached. Heat-sink temperatures were controlled manually by adjusting the liquid-nitrogen flow. A typical test run consisted of cooling the environmental chamber to the desired temperature then applying liquid-nitrogen to the holding-fixture heat sinks. Upon achieving the desired environmental and heat-sink temperatures, the thermocouple temperature recorders were turned on. Temperatures were continuously recorded for alternate periods of 3,650-psig and zero-psig supply pressure, simulating the on-off auxiliary-pump operation.

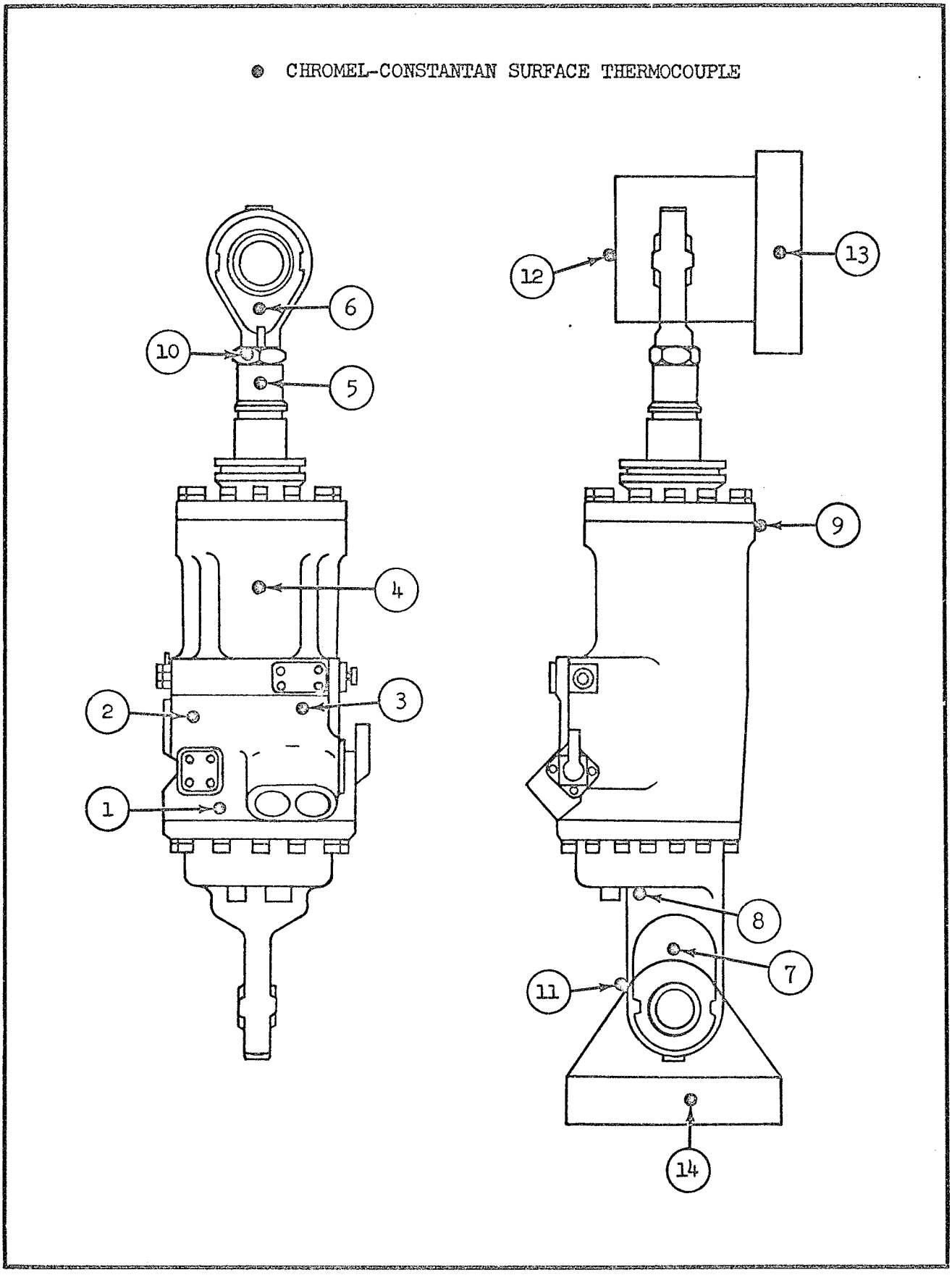


Figure 26. Thermocouple Locations, Resistance to Heat Flow Test

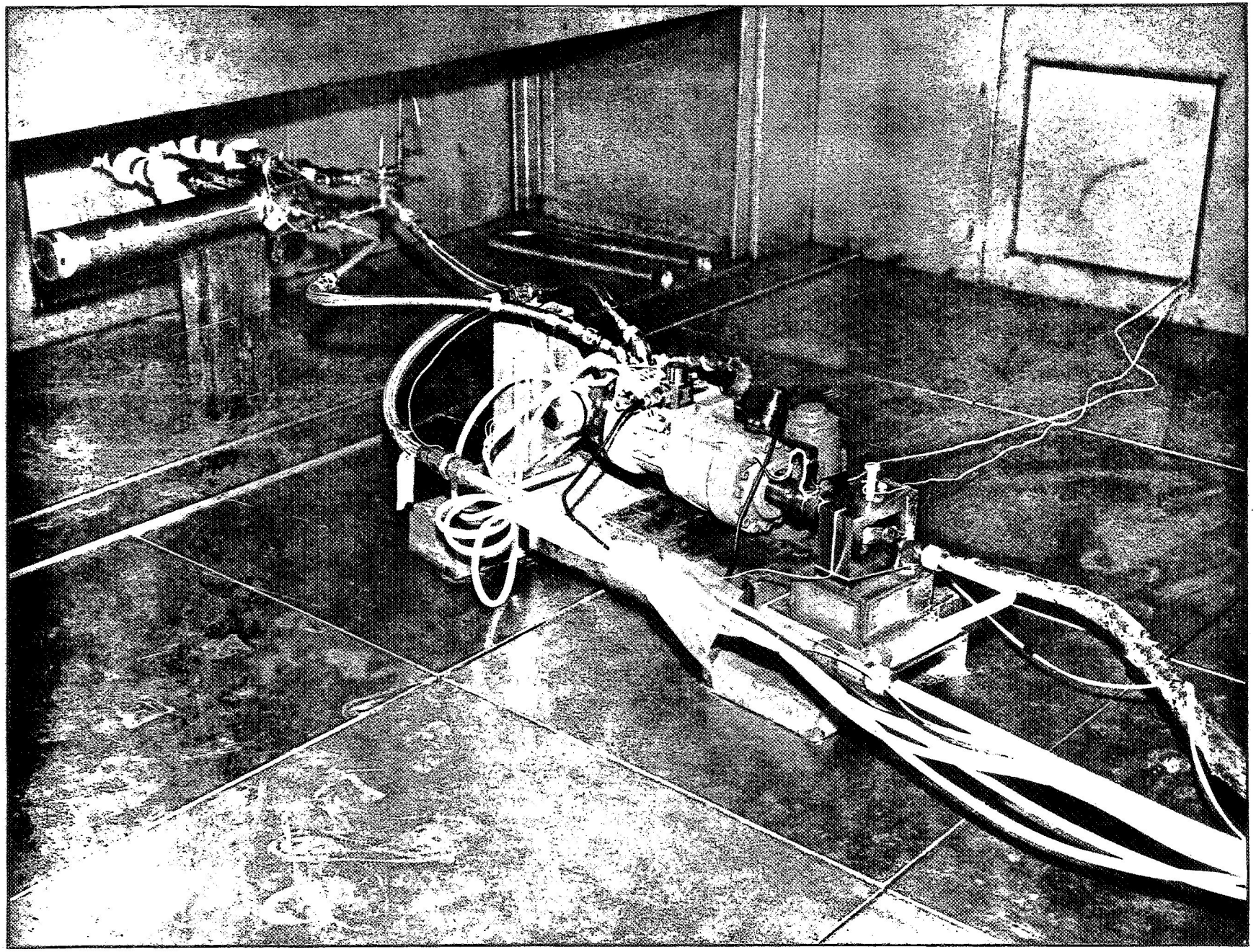


Figure 27. Resistance to Heat Flow Test Setup

2.2.7.3 Results

Four test runs at various chamber temperatures were performed, two at a chamber temperature of -25°F, one at -45°F, and one at -65°F. It was not possible to get the chamber down to the required -80°F; consequently, the temperature of -65°F was accepted in place of -80°F. Plots of temperature versus time for the four test runs are presented in charts 12 through 15. The temperature-versus-time curves reflect fairly uniform heating of the aluminum body due to hydraulic leakage flow. On the other hand, the titanium ends appear to be adequate heat barriers to insulate the actuator from the low-temperature attach points. Frequency response tests performed after the resistance-to-heat-flow test showed that the room-temperature response of the actuator remained within specification limits. See charts 16 and 17 and Table 4-14.

2.2.7.3.1 Test Run 1

The temperature-versus-time curves for test run 1 (chart 12), as well as the curves for the other runs (charts 13 through 15), represent a test interval after environmental temperature equilibrium had been achieved. In run 1, the environmental chamber was conditioned to -25°F, the hydraulic fluid to +25°F, and the heat sinks between -180° and -240°F (some difficulty was experienced in manually controlling the heat-sink temperatures). The preceding temperature conditions existed up to T (time) = 0 as stable temperatures. At point A (T = 0), 3,650-psig hydraulic supply pressure was applied to the actuator at +25°F. A command signal of ±10 ma at 0.2 cps was also applied at point A. At point B, the cycling was stopped. At point C, the supply pressure was reduced to zero psig.

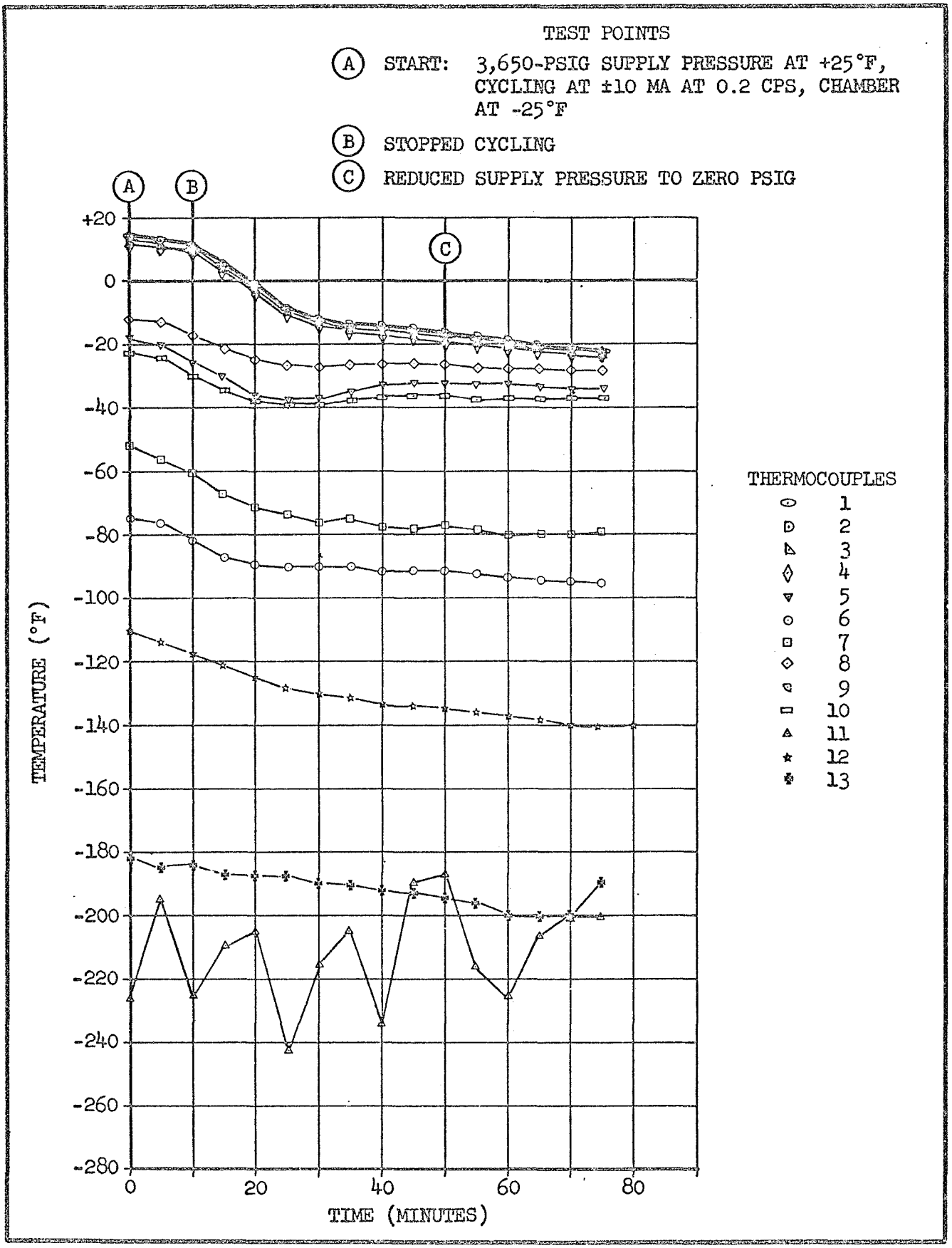


Chart 12. Actuator Resistance to Heat Flow, Run 1 - Test Specimen No. 2

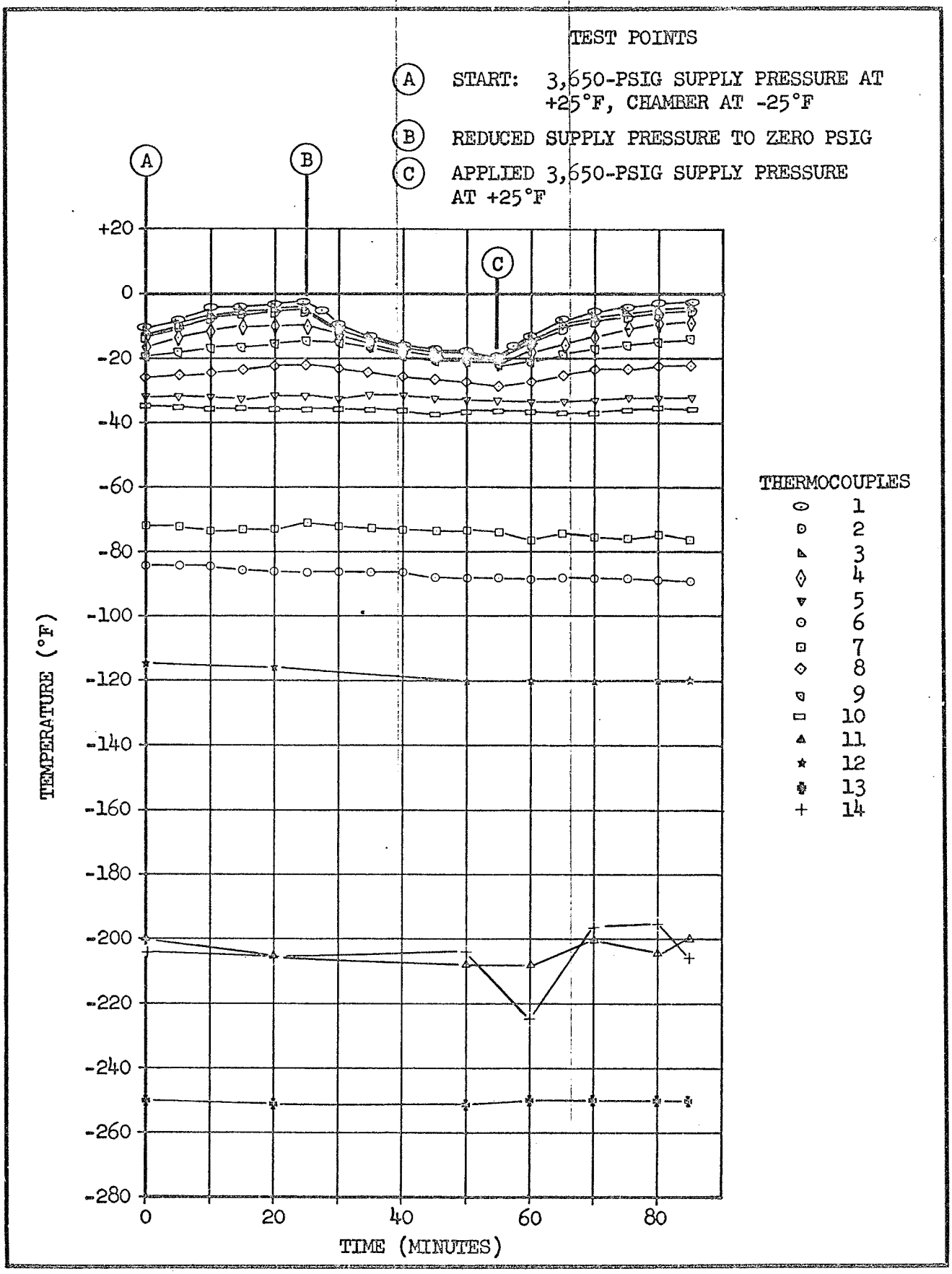


Chart 13. Actuator Resistance to Heat Flow, Run 2 - Test Specimen No. 2

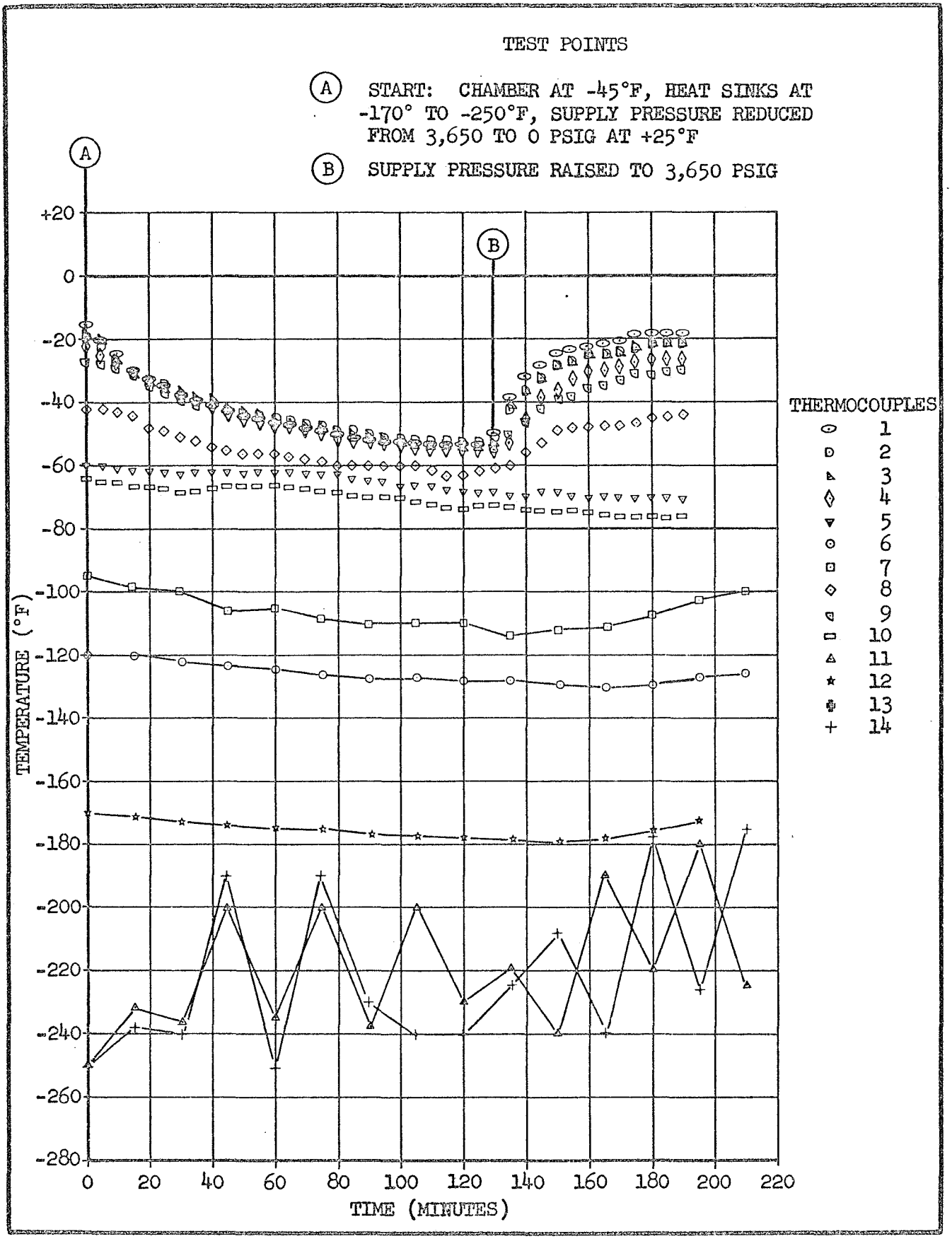


Chart 14. Actuator Resistance to Heat Flow, Run 3 - Test Specimen No. 2

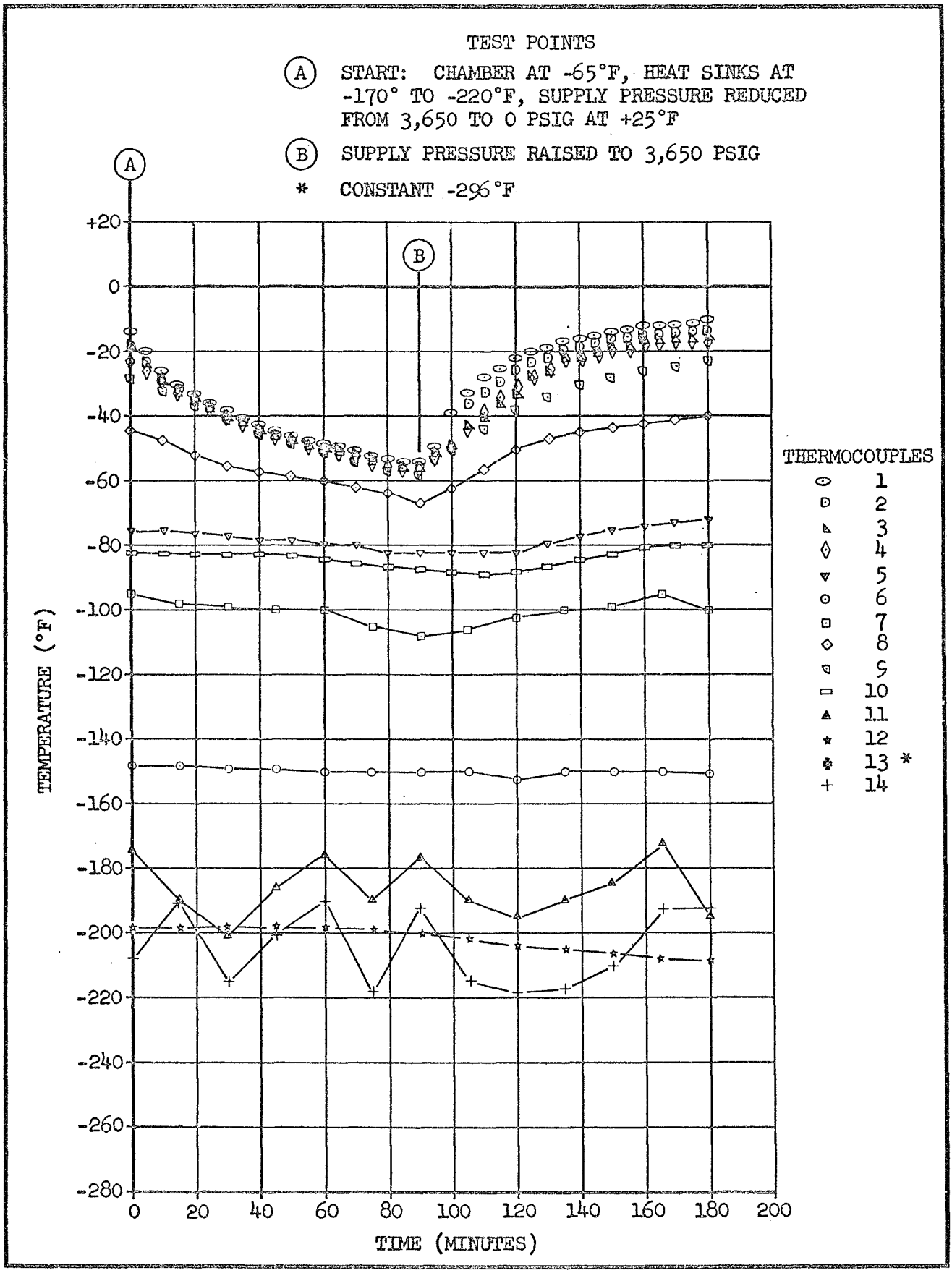


Chart 15. Actuator Resistance to Heat Flow, Run 4 - Test Specimen No. 2

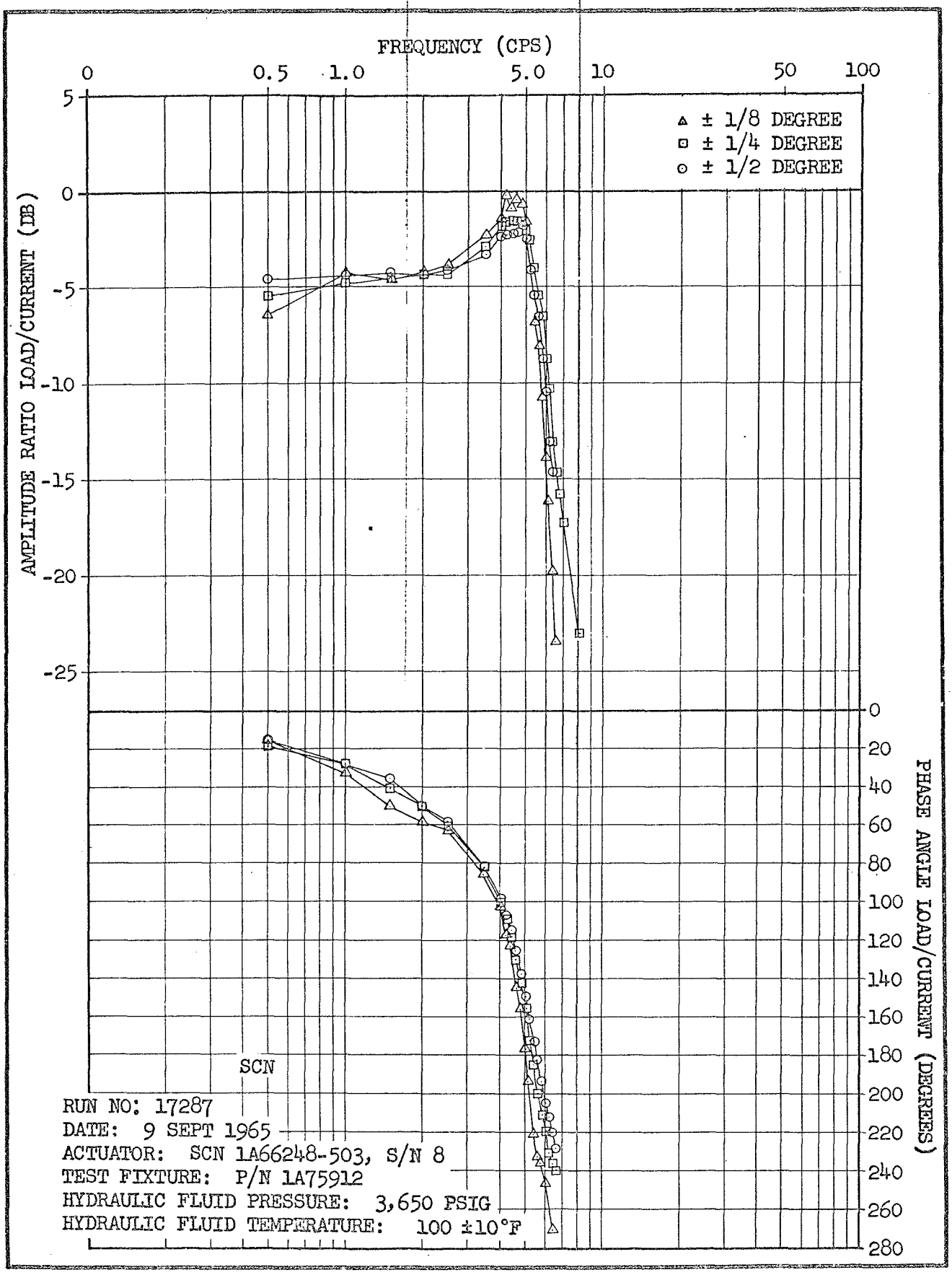


Chart 16. Post-Resistance to Heat Flow Frequency Response, Load/Current - Test Specimen 2

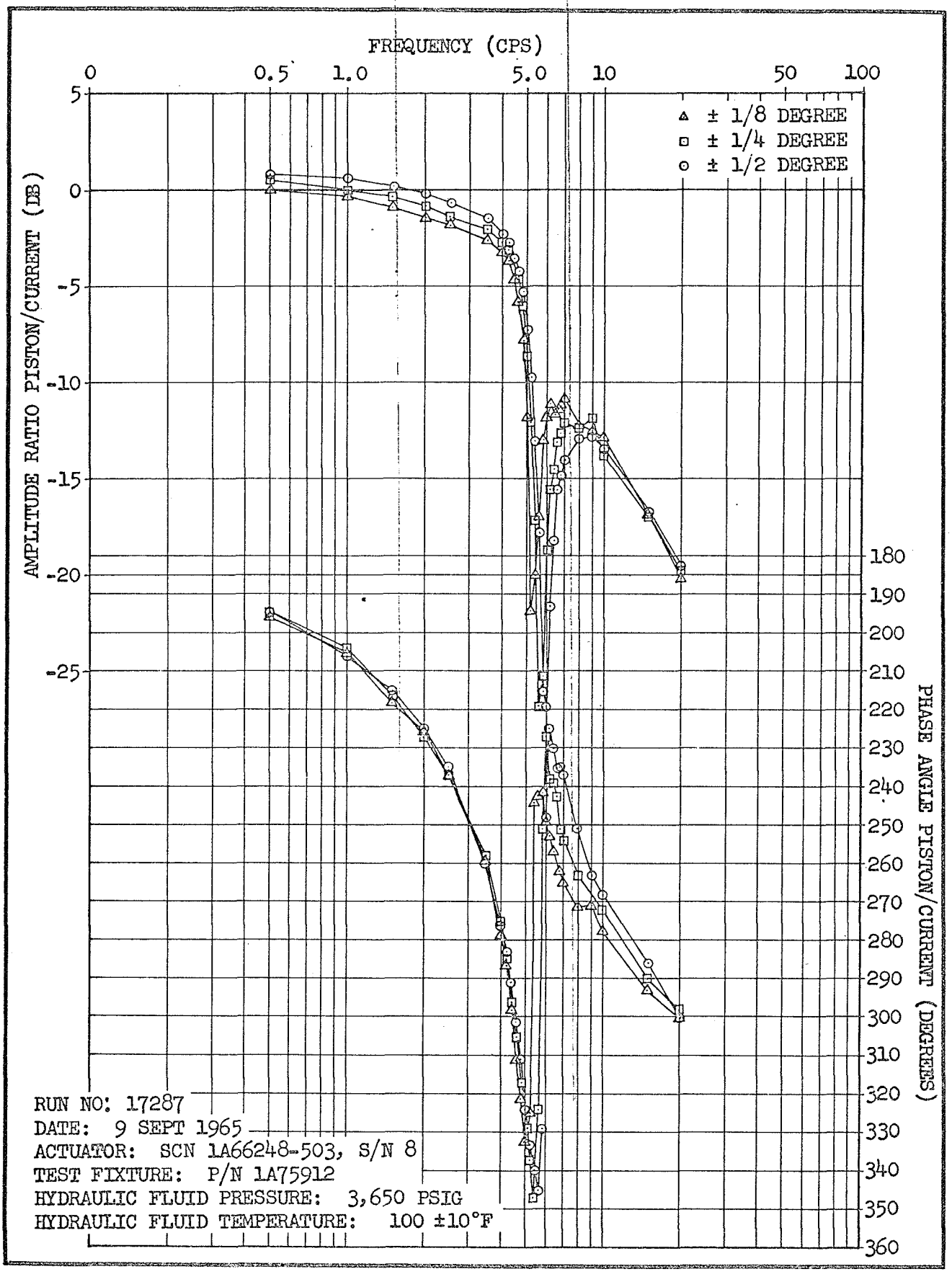


Chart 17. Post-Resistance to Heat Flow Frequency Response, Piston/Current - Test Specimen No. 2

2.2.7.3.2 Test Run 2

This run was essentially a repetition of test run 1; however, the cycling was omitted. Before T = 0, the equilibrium conditions were: chamber temperature at -25°F, hydraulic-fluid temperature at +25°F, heat-sink temperatures at -190° to -250°F, and hydraulic-fluid pressure at zero psig. At point A (T = 0), 3,650-psig hydraulic supply pressure at +25°F was applied to the actuator. At point B, the supply pressure was reduced to zero psig. At point C, the supply pressure was raised to 3,650 psig. Refer to chart 13.

2.2.7.3.3 Test Run 3

For run 3, the equilibrium conditions before T = 0 were: chamber temperature at -45°F, hydraulic-fluid temperature at +25°F, heat-sink temperatures at -170° to -250°F, hydraulic supply pressure at 3,650 psig, and no input command. At point A (T = 0), supply pressure was reduced from 3,650 to zero psig. At point B, the supply pressure was raised to 3,650 psig. Refer to chart 14.

2.2.7.3.4 Test Run 4

For run 4, the equilibrium conditions before T = 0 were: chamber temperature at -65°F, hydraulic-fluid temperature at +25°F, heat-sink temperatures at -170° to -200°F, hydraulic supply pressure at 3,650 psig, and no input command. At point A (T = 0), supply pressure was reduced from 3,650 to zero psig. At point B, the supply pressure was raised to 3,650 psig. Refer to chart 15.

2.2.8 Electromagnetic Interference

2.2.8.1 Requirements

2.2.8.1.1 Conducted Interference

Radio interference voltages generated by the actuator assembly in the frequency range of 0.15 to 25 mc shall not appear on any conductor, external to the actuator, in amounts which could interfere with other equipment.

2.2.8.1.2 Radiated Interference

Radiated interference fields of intensities which could interfere with other equipment shall not radiate from the actuator assembly, any of its components, or interconnecting wiring, over the frequency range of 0.15 to 10,000 mc for cw and pulsed cw interference, and 0.15 to 400 mc for broadband impulse interference.

2.2.8.2 Procedures

2.2.8.2.1 Test Setup

The actuator assembly was placed on a ground plane in a shielded enclosure as shown in figures 28 and 29. All input wires to the unit were filtered and shielded at the source to eliminate interference generated by the driving oscillator and amplifier.

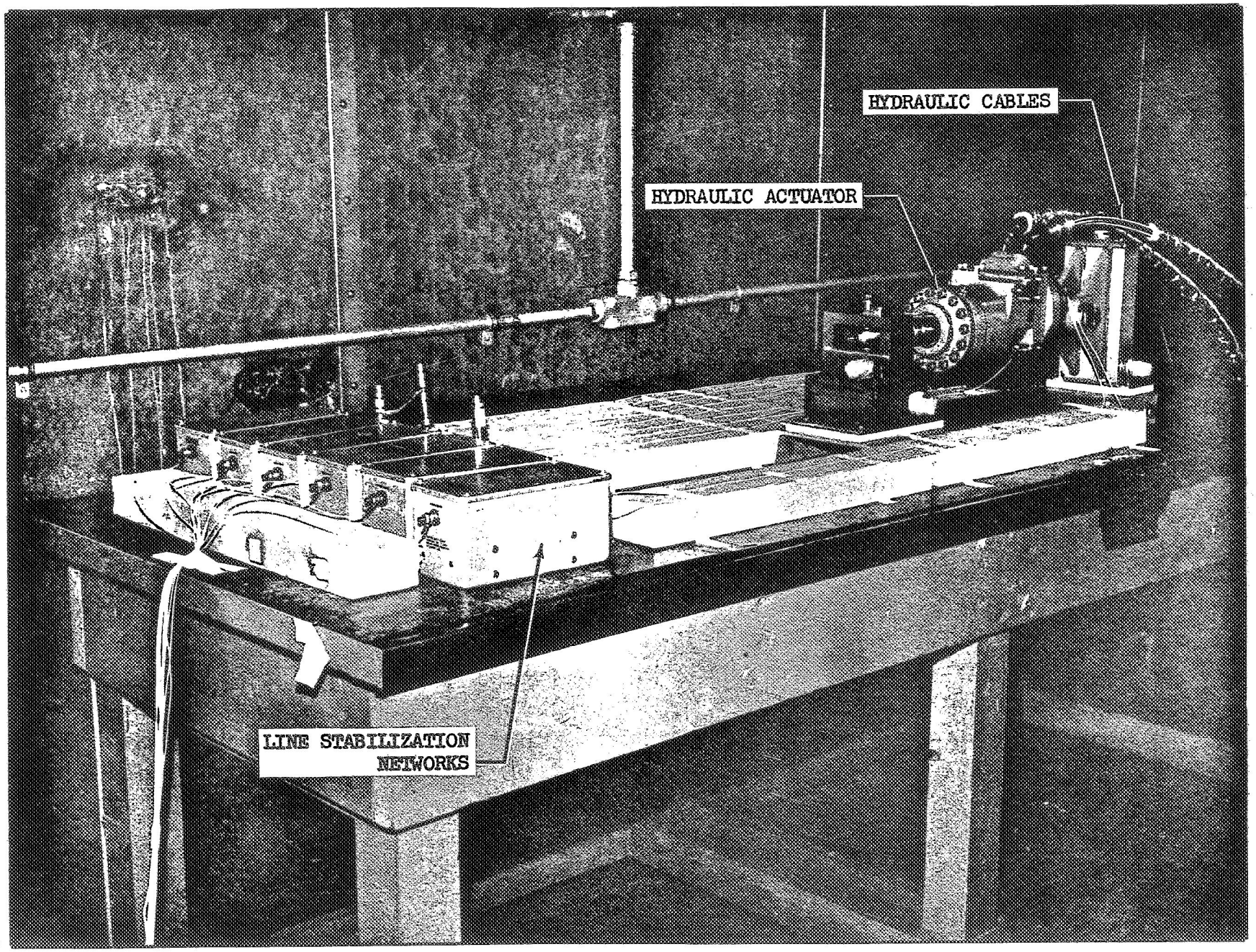


Figure 28. Electromagnetic Interference Test Setup

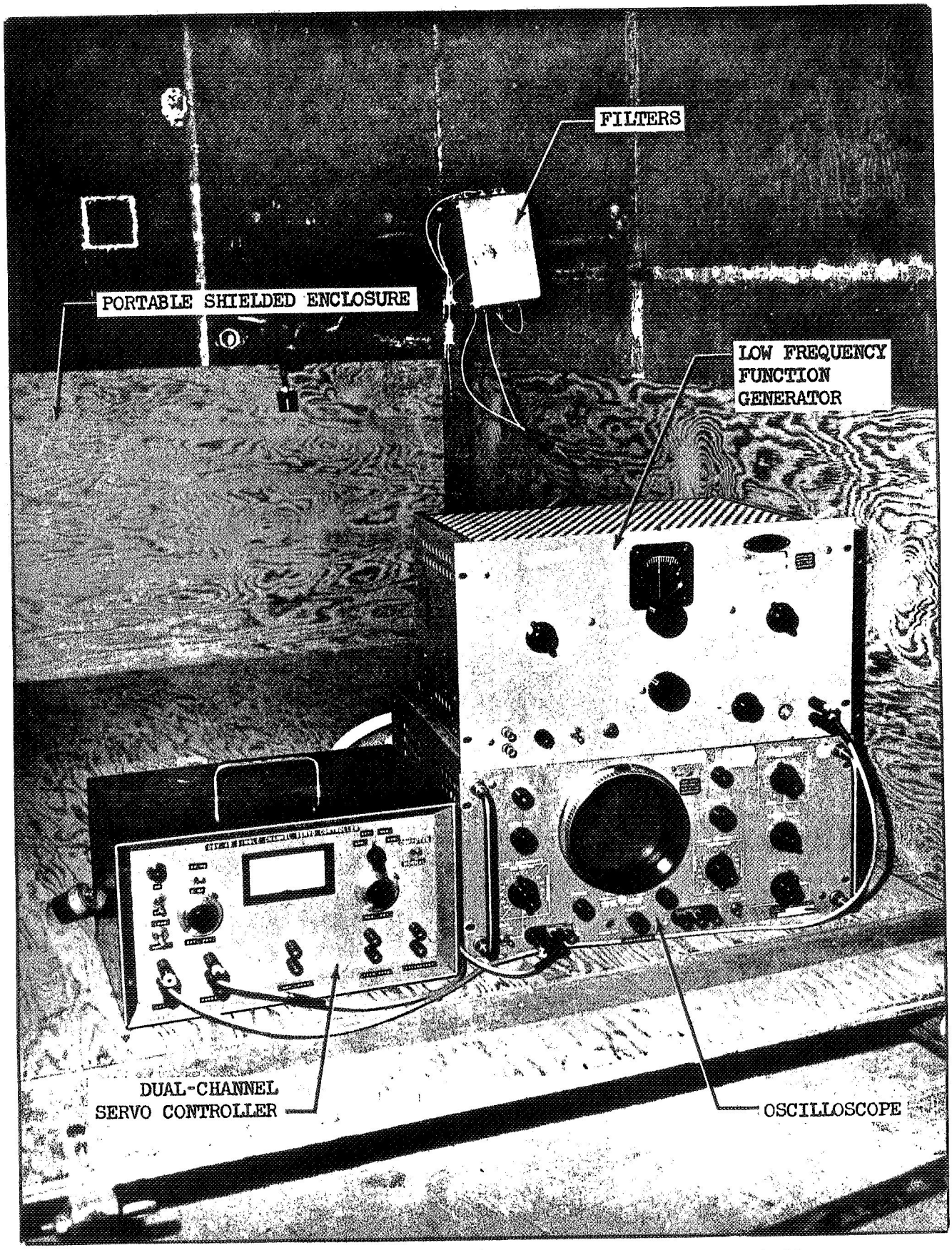


Figure 29. Electromagnetic Interference Test Instrumentation

2.2.8.2.2 Conducted Interference

Interference voltages in the frequency range of 0.15 to 25 mc were measured on all input lines by connecting an RIFI meter to the test terminals on the line stabilization networks.

2.2.8.2.3 Radiated Interference

Radiated interference fields were measured in the frequency range of 0.15 to 400 mc, using rod and dipole antennas as integral parts of the RIFI meters. Testing in the remainder of the frequency spectrum was omitted because the actuator assembly, by analysis, is incapable of generating interference in this range.

2.2.8.3 Results

2.2.8.3.1 Conducted Interference

The broadband and pulsed (cw) conducted interference levels, measured as described in paragraph 2.2.8.2.2, are shown on charts 18 through 23. These interference levels were within the test requirements outlined in paragraph 2.2.8.1.1.

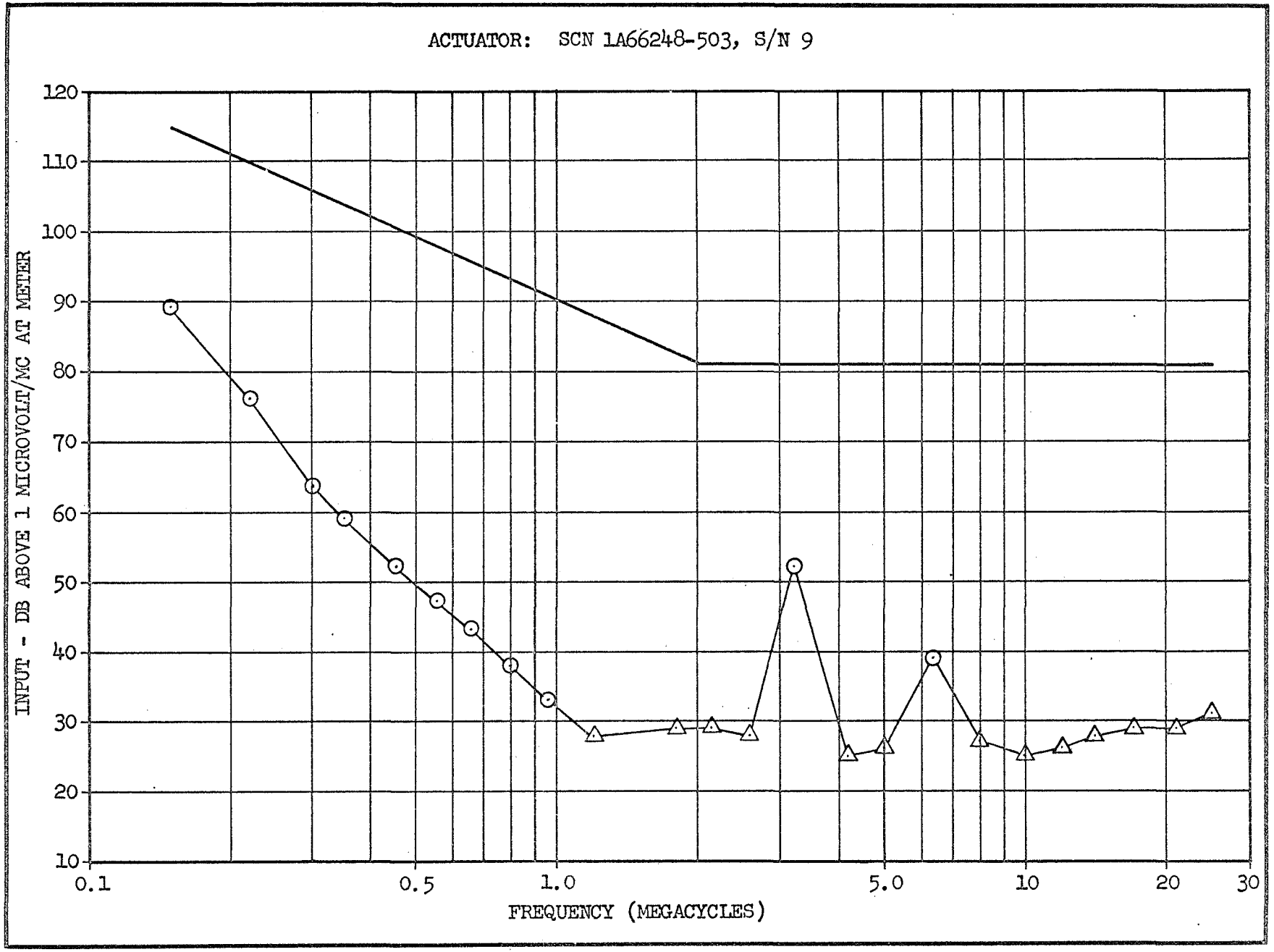


Chart 18. Conducted Interference, Actuator Feedback Line E - Test Specimen No. 3

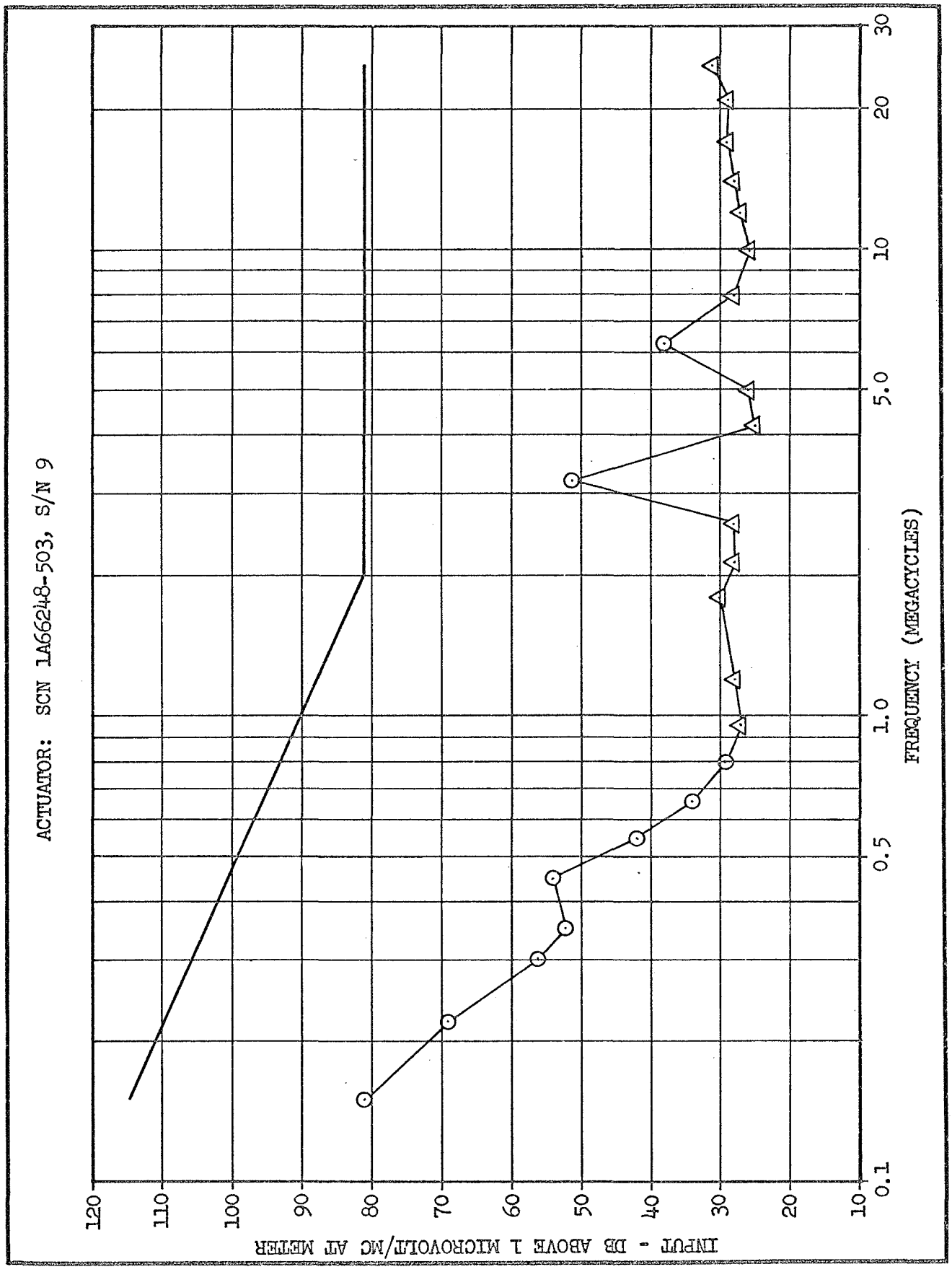


Chart 19. Conducted Interference, Actuator Feedback Line G - Test Specimen No. 3

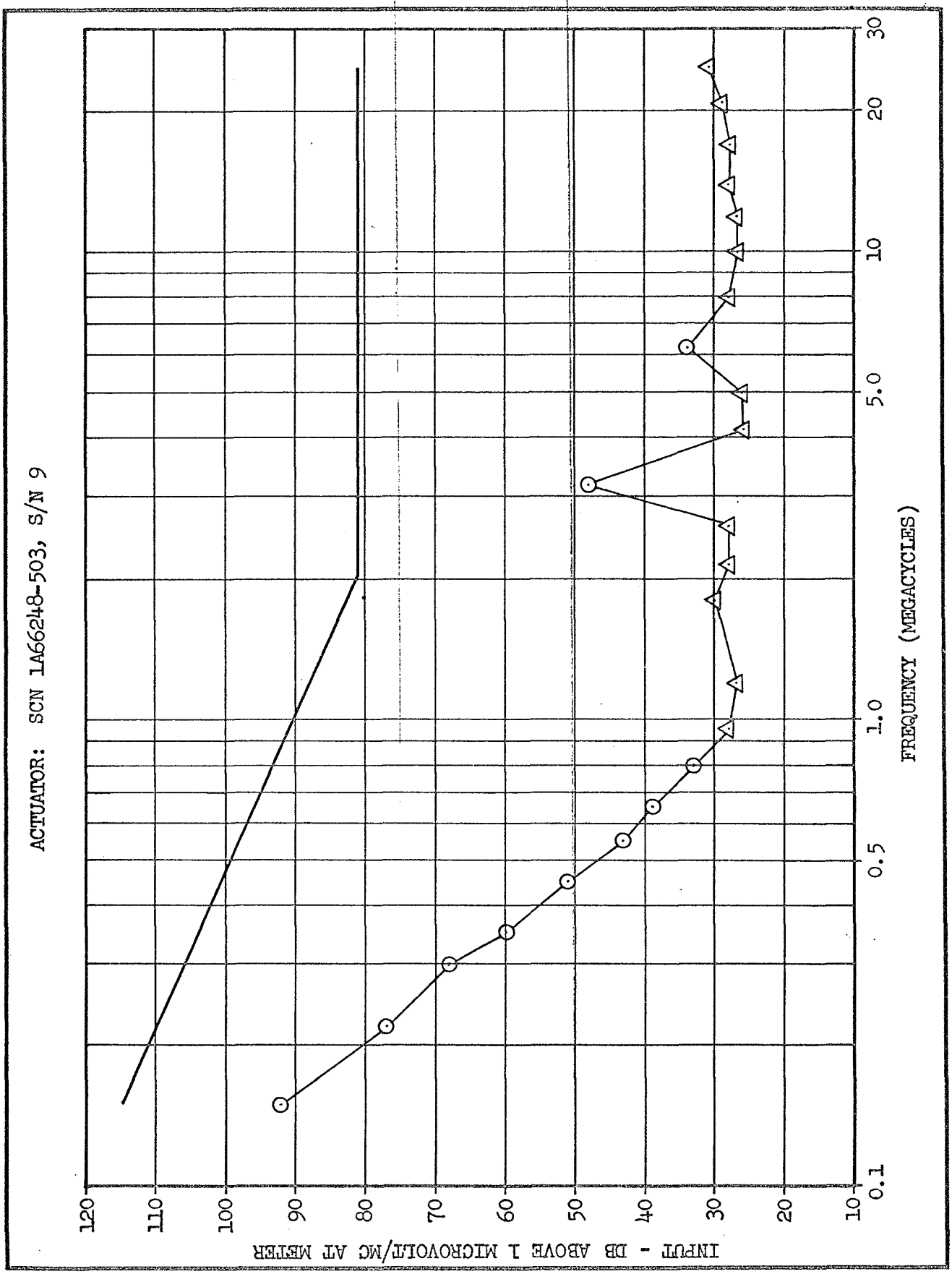


Chart 20. Conducted Interference, Actuator Feedback Line C - Test Specimen No. 3

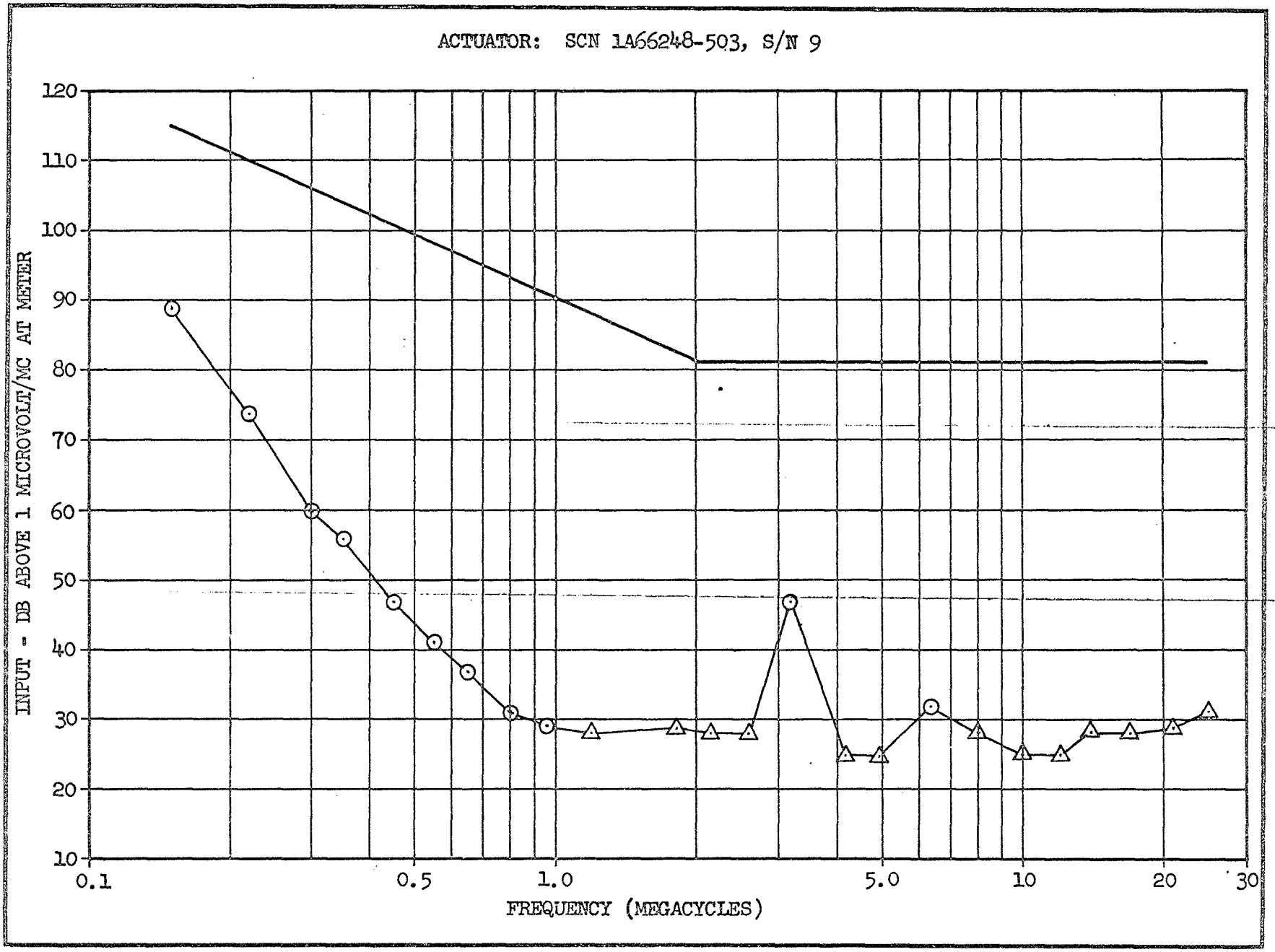


Chart 21. Conducted Interference, Actuator Feedback Line A - Test Specimen No. 3

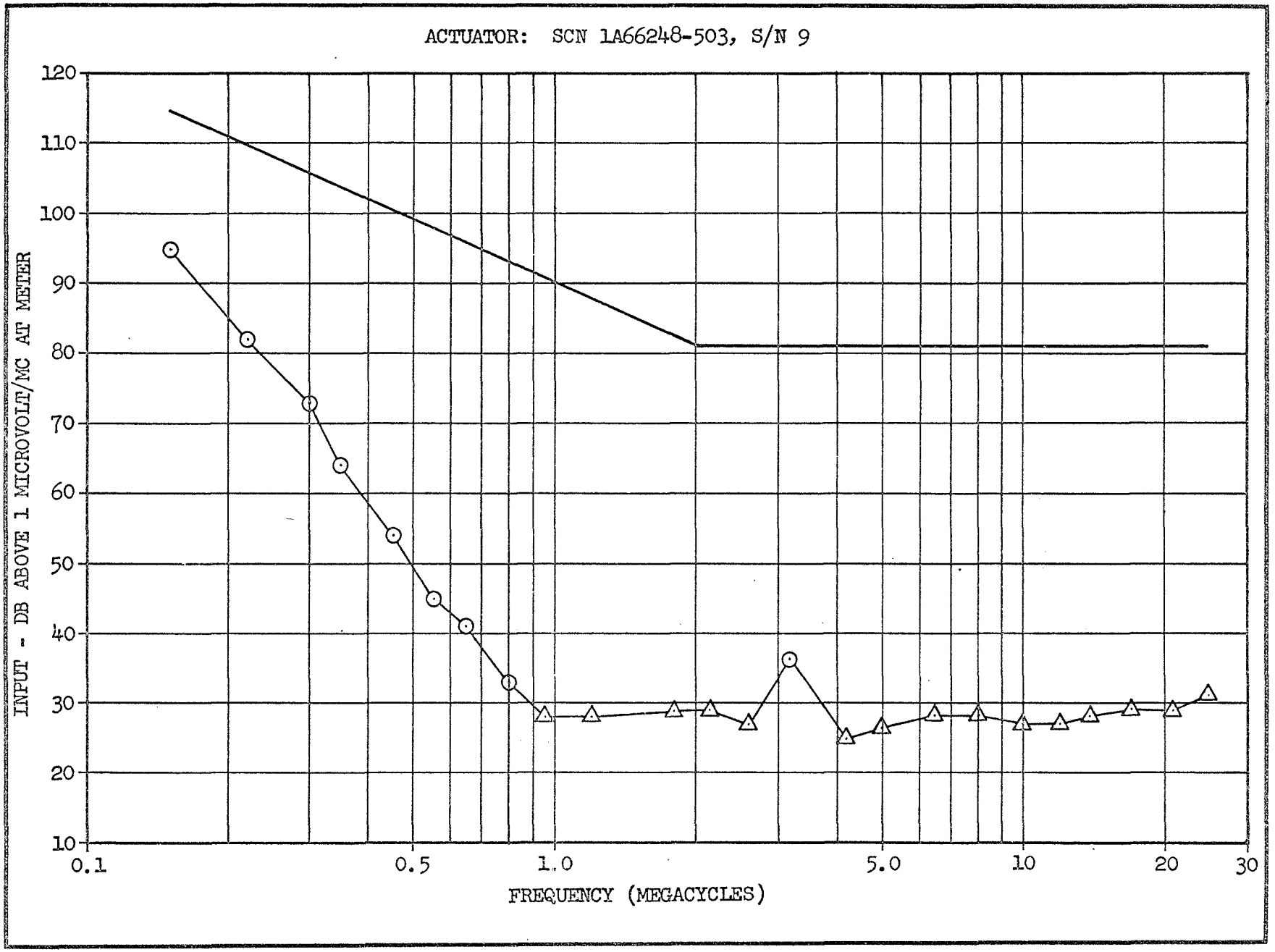


Chart 22. Conducted Interference, Servovalve Input Line B - Test Specimen No. 3

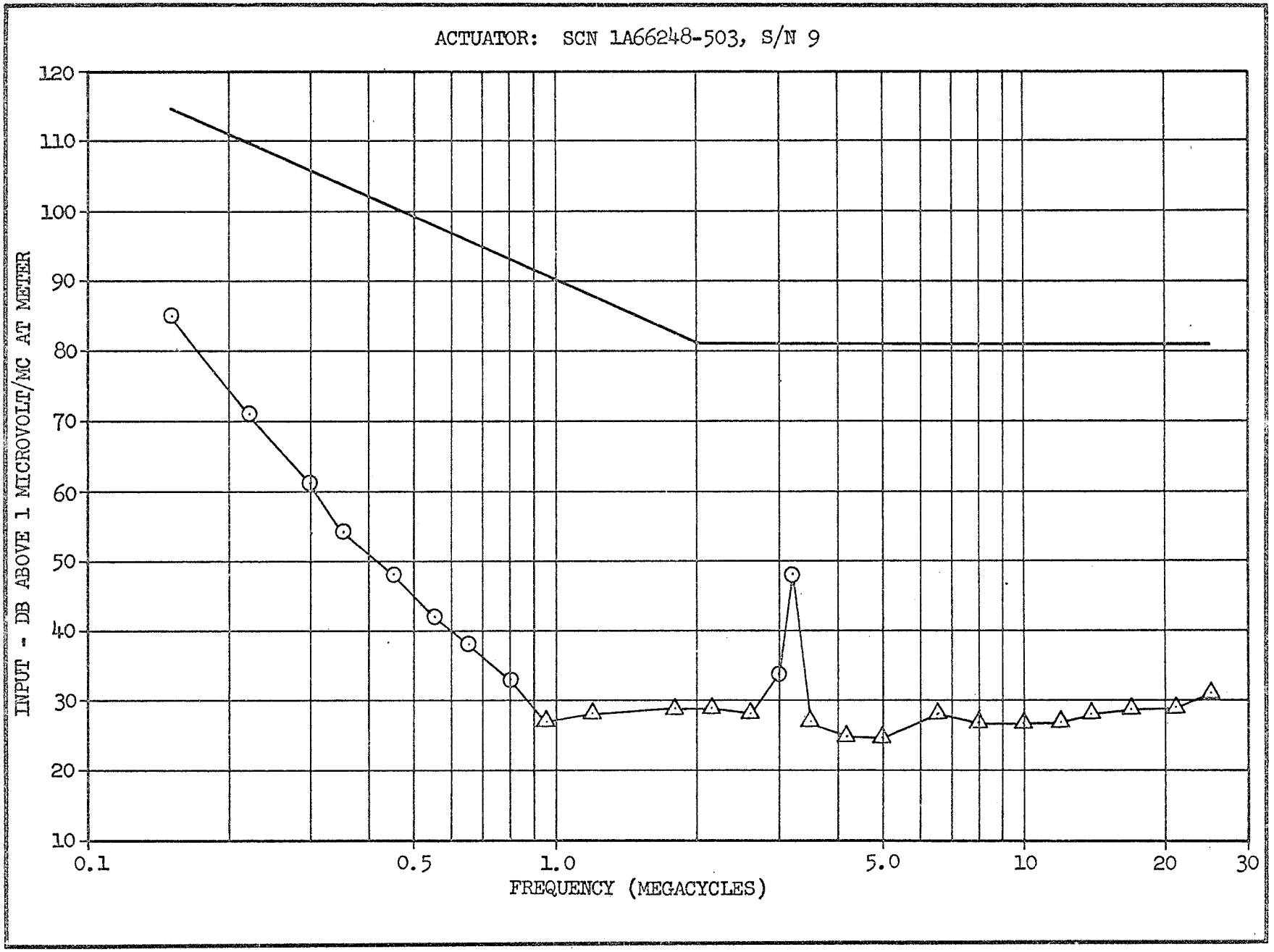


Chart 23. Conducted Interference, Servovalve Input Line A - Test Specimen No. 3

2.2.8.3.2 Radiated Interference

The broadband and pulsed (cw) radiated interference levels, measured as described in paragraph 2.2.8.2.3, are shown on chart 24. The interference generated was within the test requirements outlined in paragraph 2.2.8.1.2.

2.2.8.3.3 Post-Test Frequency Response

Results of the frequency response tests, following the electromagnetic tests, are given in chart 25 and Table 4-15.

2.2.9 Life Cycle (Axial Load)

2.2.9.1 Requirements

There shall be no evidence of leakage, damage, or maladjustment when the actuator assembly is subjected to the following series of cycles.

a. 5,000 cycles at full actuator stroke, cycling at the maximum hydraulic power output of the servovalve.
b. 10,000 cycles at one-half actuator stroke, cycling at half the maximum hydraulic power output of the servovalve.
c. 100,000 cycles with constant amplitude signals equivalent to 1 per cent and 25 per cent of the actuator stroke, each amplitude for a duration of 8 minutes at the following frequencies: 0.2, 0.4, 0.6, 1.0, 2.0, 2.5, 3.0, 3.5, 7.5, 8.0, 8.5, 9.0, 10, 12, 16, and 20 cps.

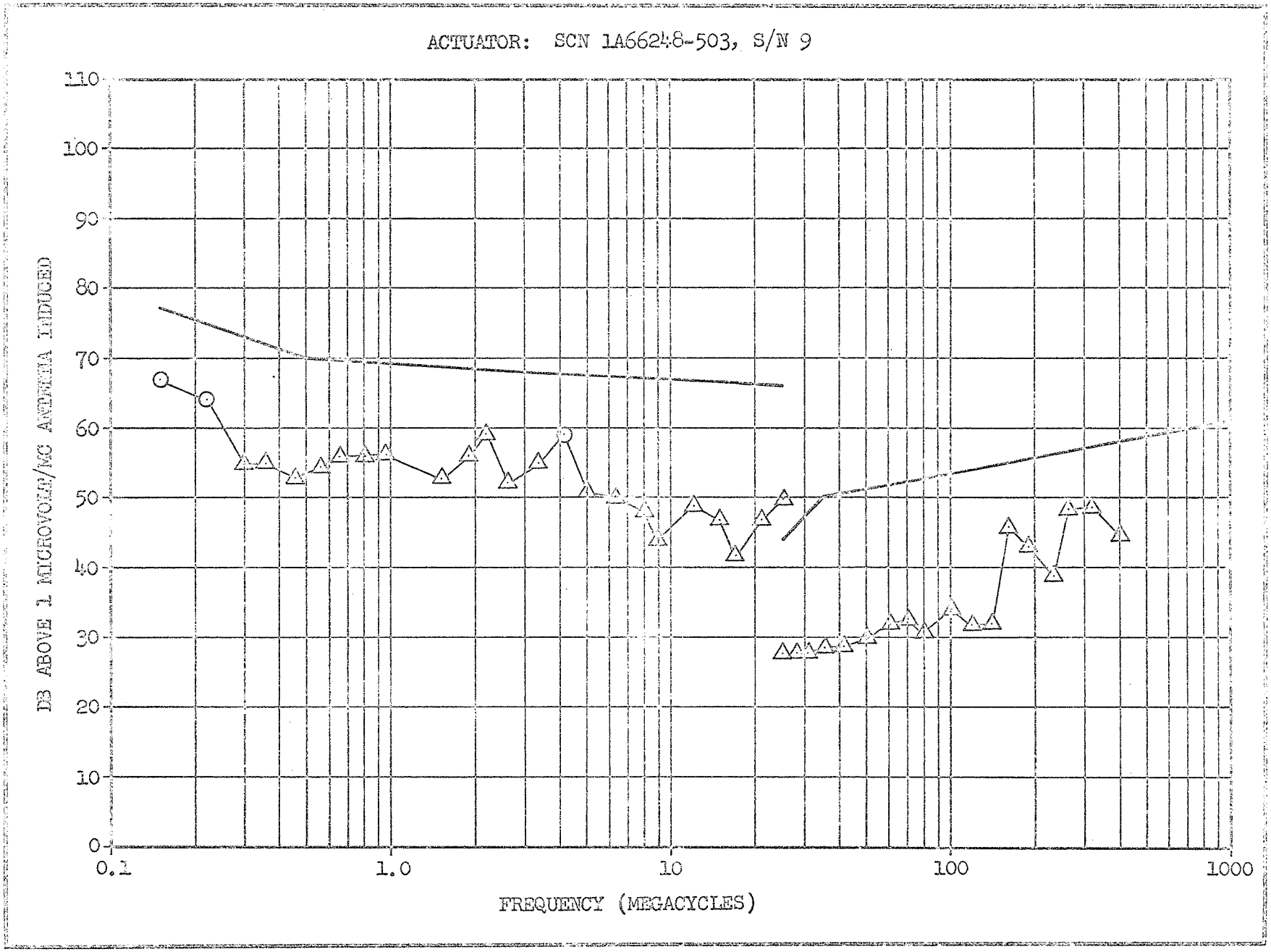


Chart 24. Radiated Interference, Test Specimen No. 3

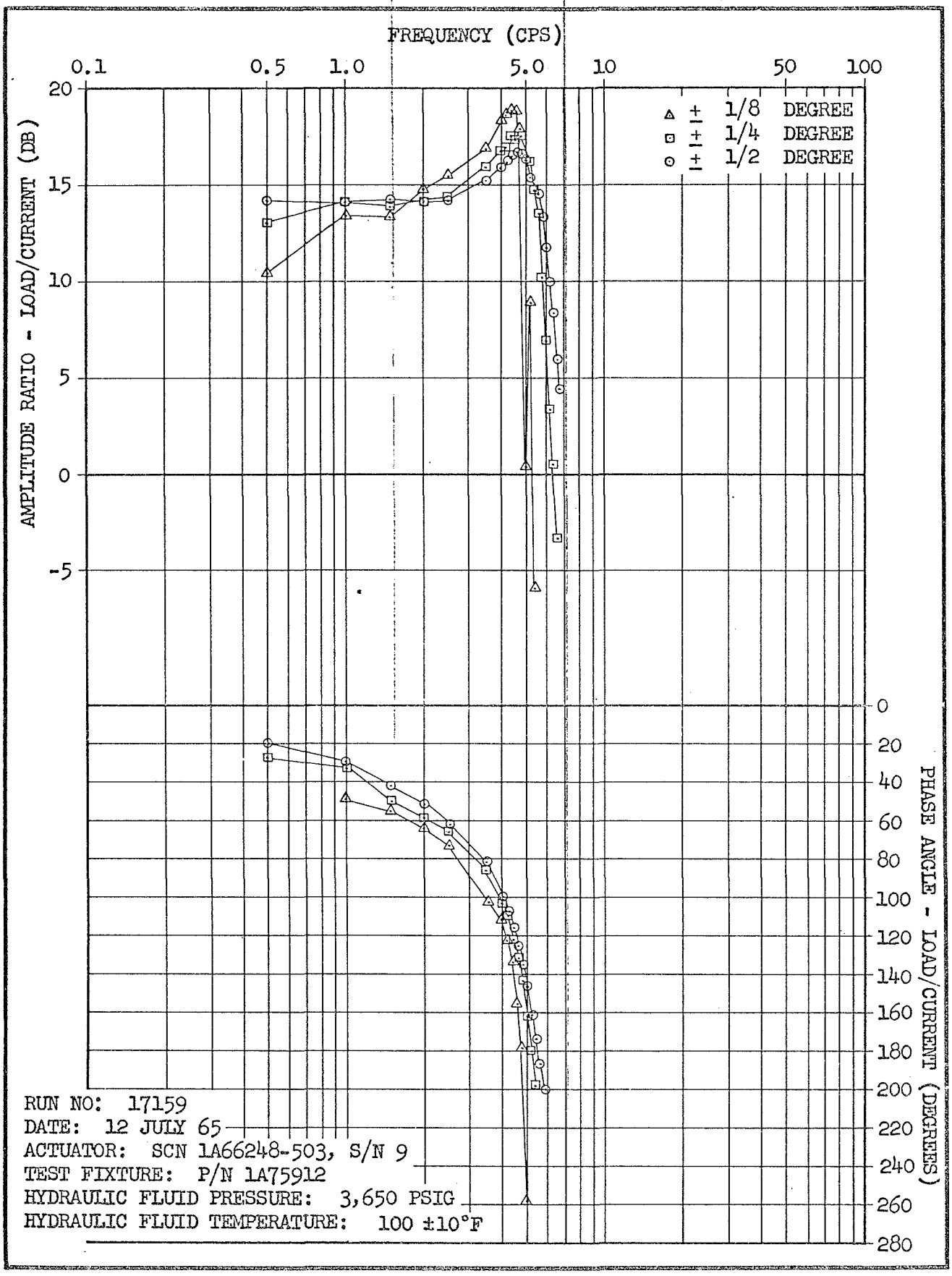


Chart 25. Post-Electromagnetic Interference Frequency Response, Load/Current - Test Specimen No. 3

2.2.9.2 Procedure

Test specimens were installed in the actuator life cycle (linear axial load) test fixtures as shown in figures 30 and 31 for the first two of the three life-cycle tests. The desired load was applied by cycling the test specimen at the required rate and amplitude and by adjusting the hand valves controlling outlet flow from the load cylinder to achieve the desired load chamber pressures. Load-cylinder force values for the 5,000- and 10,000-cycle tests were 28,500 and 14,300 pounds, respectively. These loads corresponded to test-specimen cylinder differential pressures of 2,430 and 1,215 psid, respectively. The following were the parameters of the two tests.

Test No.	Number of Cycles	Actuator Input Signal	Piston Amplitude	Load Force (lb)	Frequency (cps)
1. Half Power	10,000	Triangular	1/2 stroke	14,300	0.98
2. Full Power	5,000	Triangular	full stroke	28,500	0.35

Actuator rod-end and tail-end bearing clearances were monitored periodically throughout the tests. Bearing clearances were measured after each 1,000 applied-load cycles for the full-power tests, and after each 2,000 applied-load cycles for the half-power tests. Bearing clearance on either end was measured with dial indicators located between brackets temporarily mounted on the actuator and the actuator support references. A reversing load of 3,200 pounds was applied in the same manner as the test load, and the resulting dial indicator readings were termed bearing clearances.

The half-power test was run first, followed by the full-power test. This sequence was followed for both test specimens No. 3 and 4.

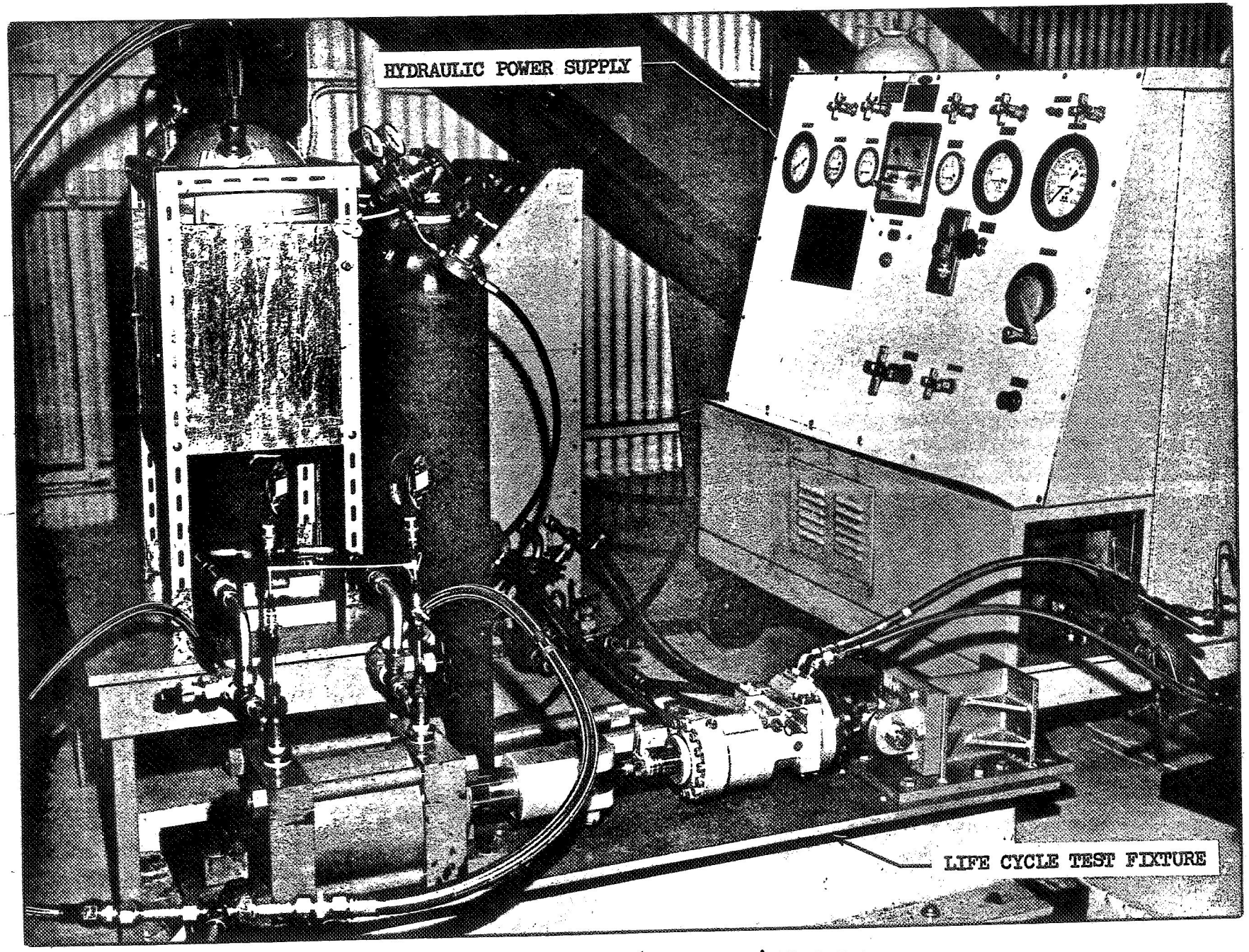


Figure 30. Life Cycle (Axial Load) Test Setup

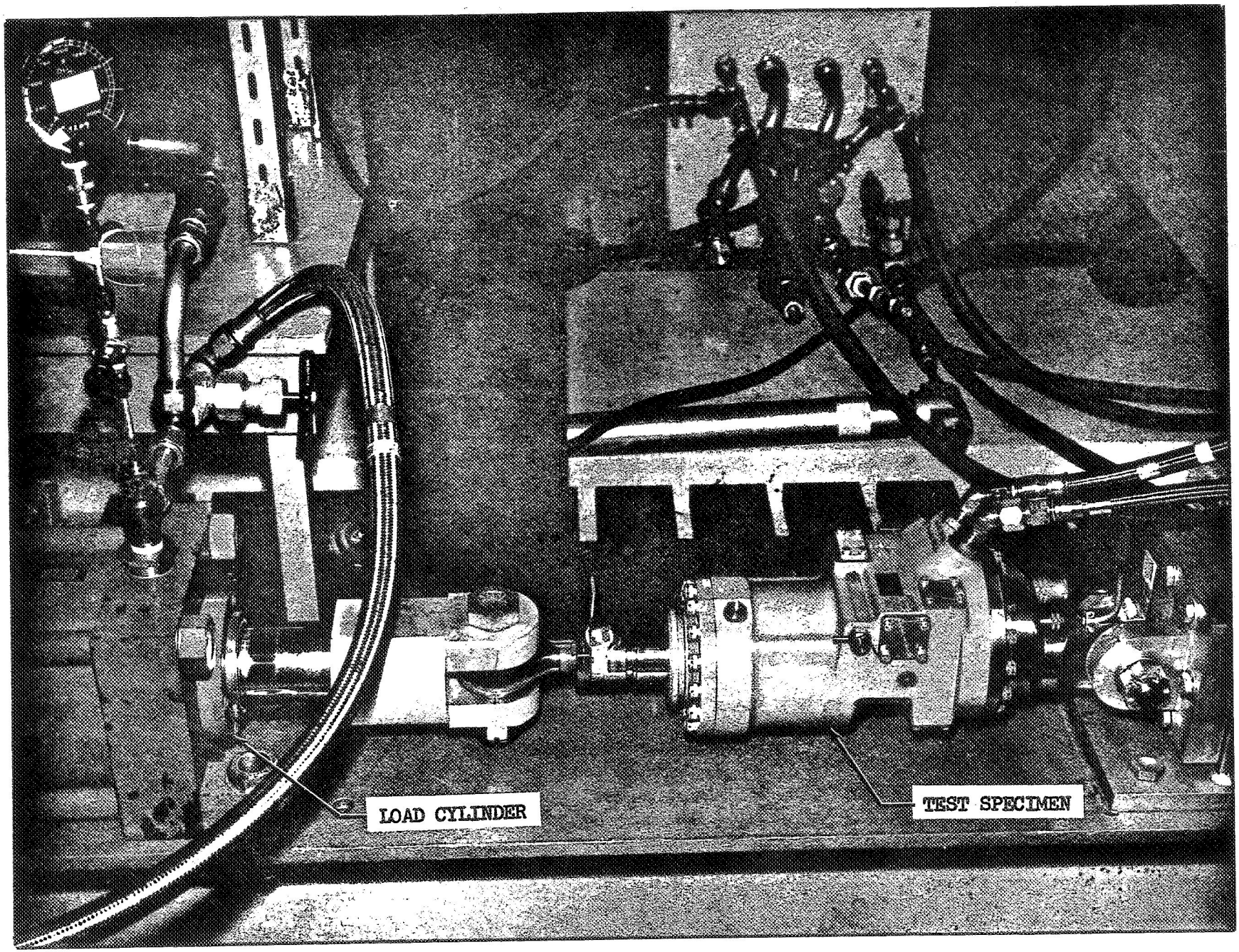


Figure 31. Actuator In Life-Cycle Test Fixture

2.2.9.2 (Continued)

The third life cycle test was performed with the actuator installed on the single-axis engine-load simulator for 100,000 cycles. Upon completion of the life cycle testing, both test specimens were given frequency response tests on the single-axis fixture.

2.2.9.3 Results

Test specimens No. 3 and 4 were subjected to all of the required life cycle tests. Test specimen No. 3 performed satisfactorily throughout all three tests and showed no evidence of damage or degradation. After successfully completing tests 1 and 2, test specimen No. 4 experienced cracking of the titanium end between the electrical connector holes during either test 3 or the post-life-cycle frequency-response test. Additional full-power cycling of test specimen No. 4 beyond the qualification test requirements resulted in complete failure of the titanium end.

Both test specimens performed satisfactorily at half- and full-power, tests 1 and 2. There was noticeable flexing of the titanium tailstock in the vicinity of the electrical connectors, but visual inspection of both test specimens, after testing, did not reveal any cracks or failure.

Bearing clearance data, accumulated on both test specimens during tests 1 and 2, are shown on chart 26. Tailstock bearing clearance for both specimens remained essentially the same at 0.0075 inch throughout life-cycle testing. Rod-end bearing clearance for specimen No. 4 during test 1 rose to a maximum of 0.027 inch at 6,000 cycles, then gradually dropped

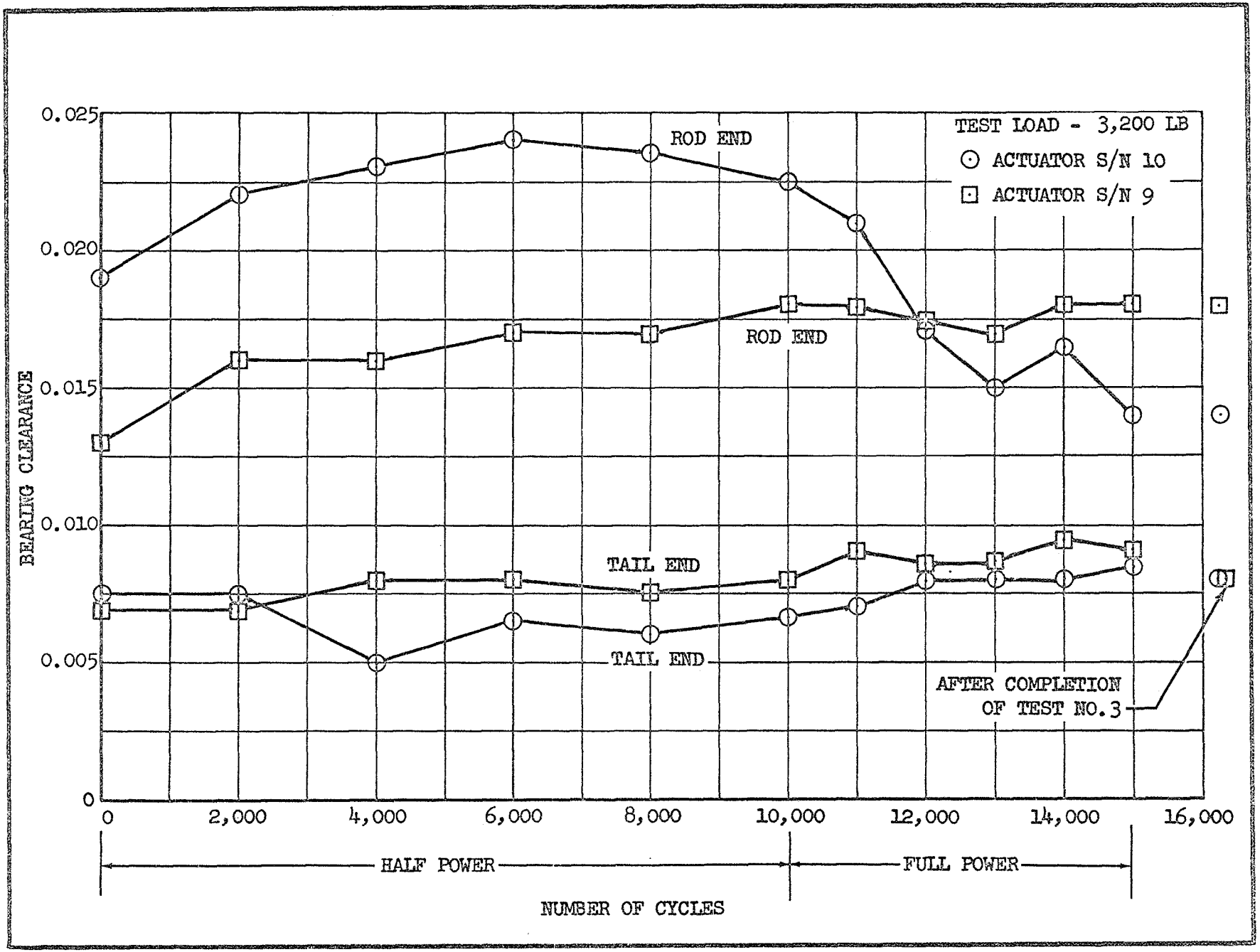


Chart 26. Attach-End Bearing Clearance, Life-Cycle Test, Specimens No. 3 and 4

2.2.9.3 (Continued)

as the 10,000-cycle point was approached, followed by a continuing drop throughout the 5,000 full-power cycles to 0.0014 inch. Rod-end bearing clearance for test specimen No. 2 increased gradually throughout tests 1 and 2 from approximately 0.0070 to 0.0080 inch. For both test specimens, the rod-end bearing clearance after test 3 was the same as the pretest value.

Post-life-cycle frequency-response tests were run on both test specimens. The results are plotted on charts 3-21 and 3-22. The load/current dynamic response of both specimens revealed no significant performance changes when compared to data taken prior to life-cycle testing.

Approximately 2 months after completion of the life-cycle testing, the titanium tailstock of test specimen No. 4 was discovered to be cracked between the two electrical connectors. The part had not been tested since the life-cycle tests; examination following life-cycle tests 1 and 2 did not reveal any sign of failure. These facts indicate that the failure occurred during either test 3 or the post-life-cycle frequency-response run. The tailstock was removed from the actuator, photographed, and zyglo-inspected. The photos are presented in figures 32 and 33. The zyglo inspection did not reveal any additional cracks. It was decided to reinstall the cracked end on the actuator and apply an additional 5,000 full-power cycles to determine if the strength of the part was still adequate. Almost immediately after cycling was resumed, cracks began propagating downward from the connector holes along the radius of the bell-tail intersection. Complete rupture, shown in figure 34, occurred at 4,920 cycles.

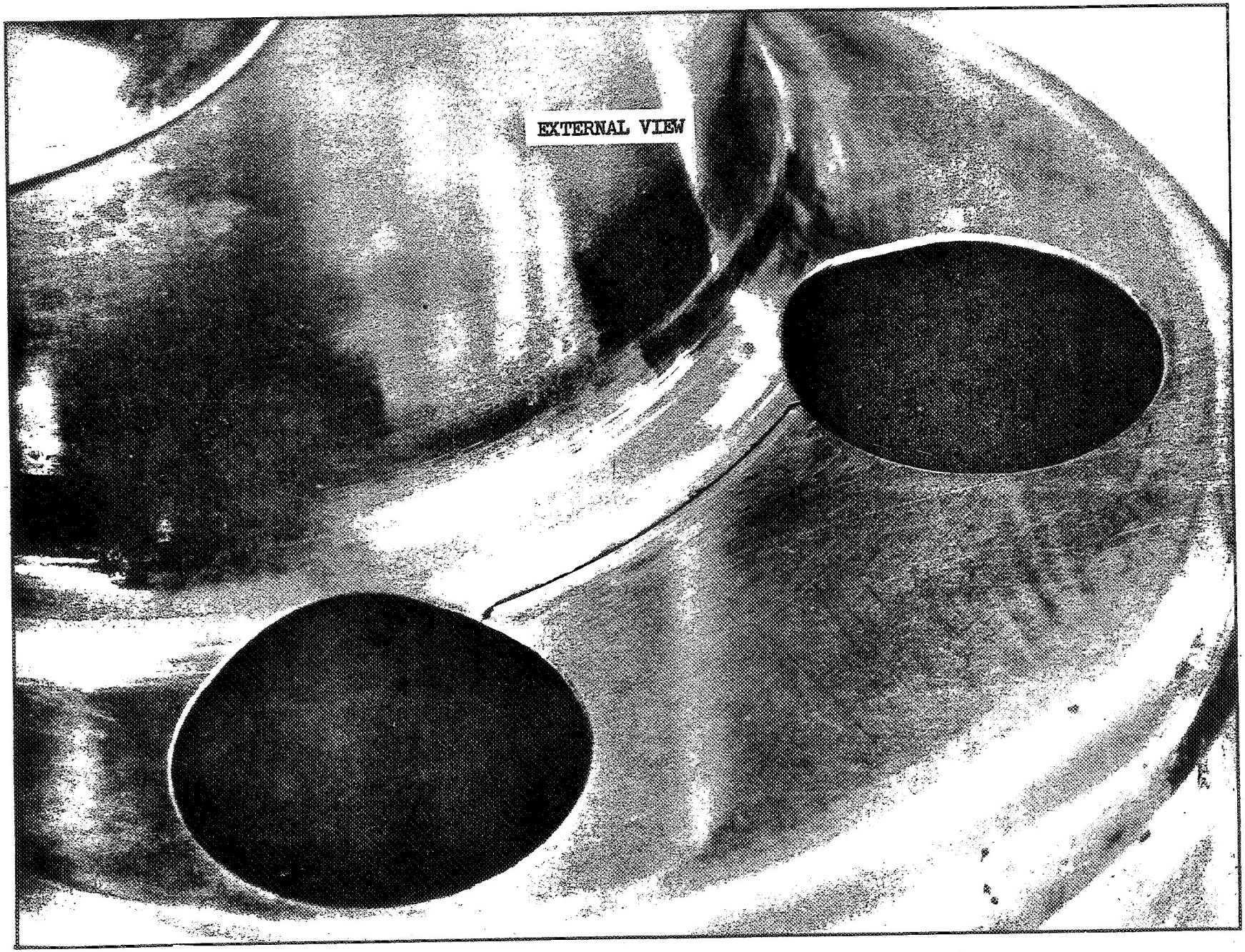


Figure 32. Damaged Titanium Tailstock, Test Specimen No. 4

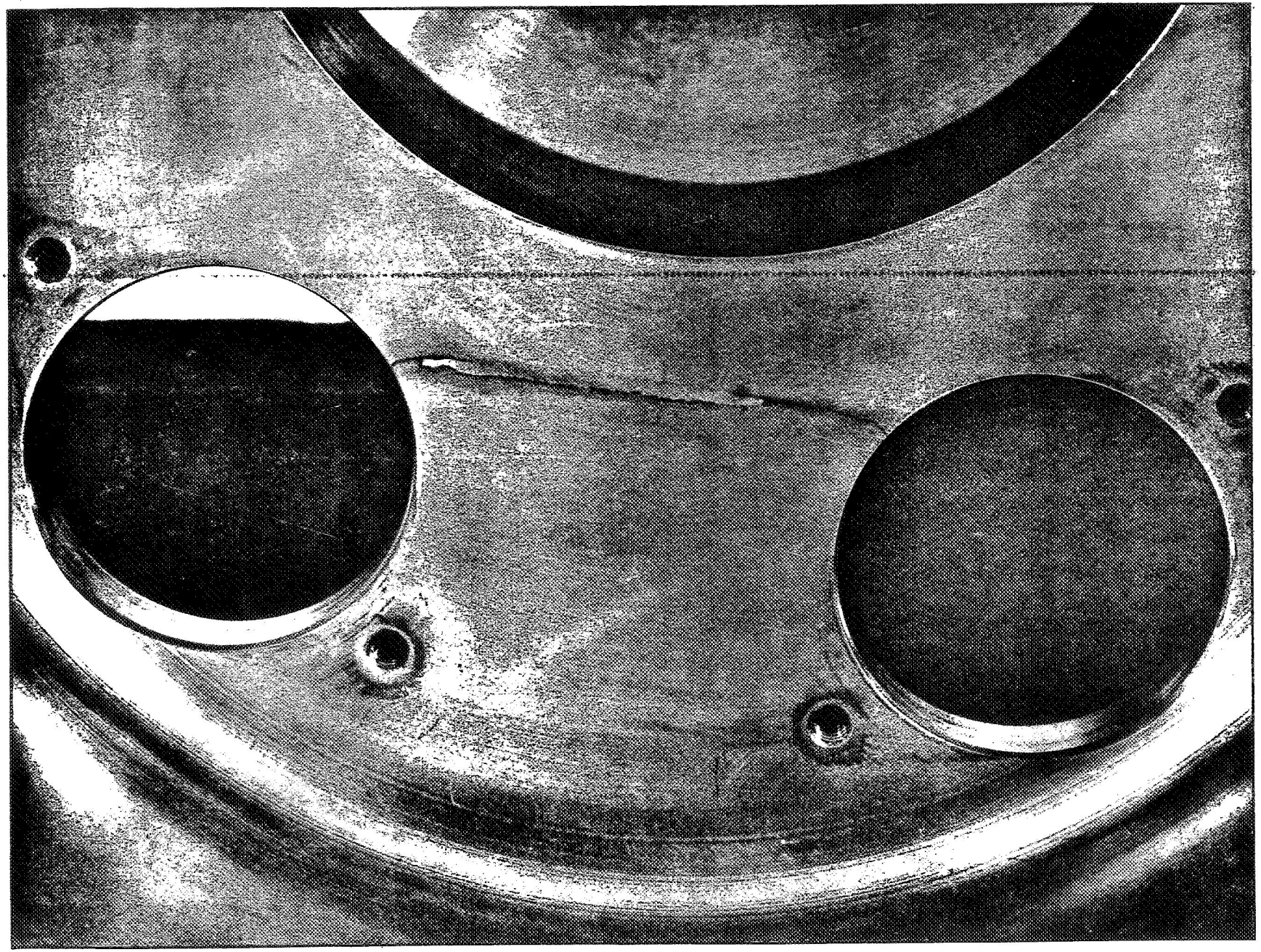


Figure 33. Damaged Titanium Tailstock, Interior View

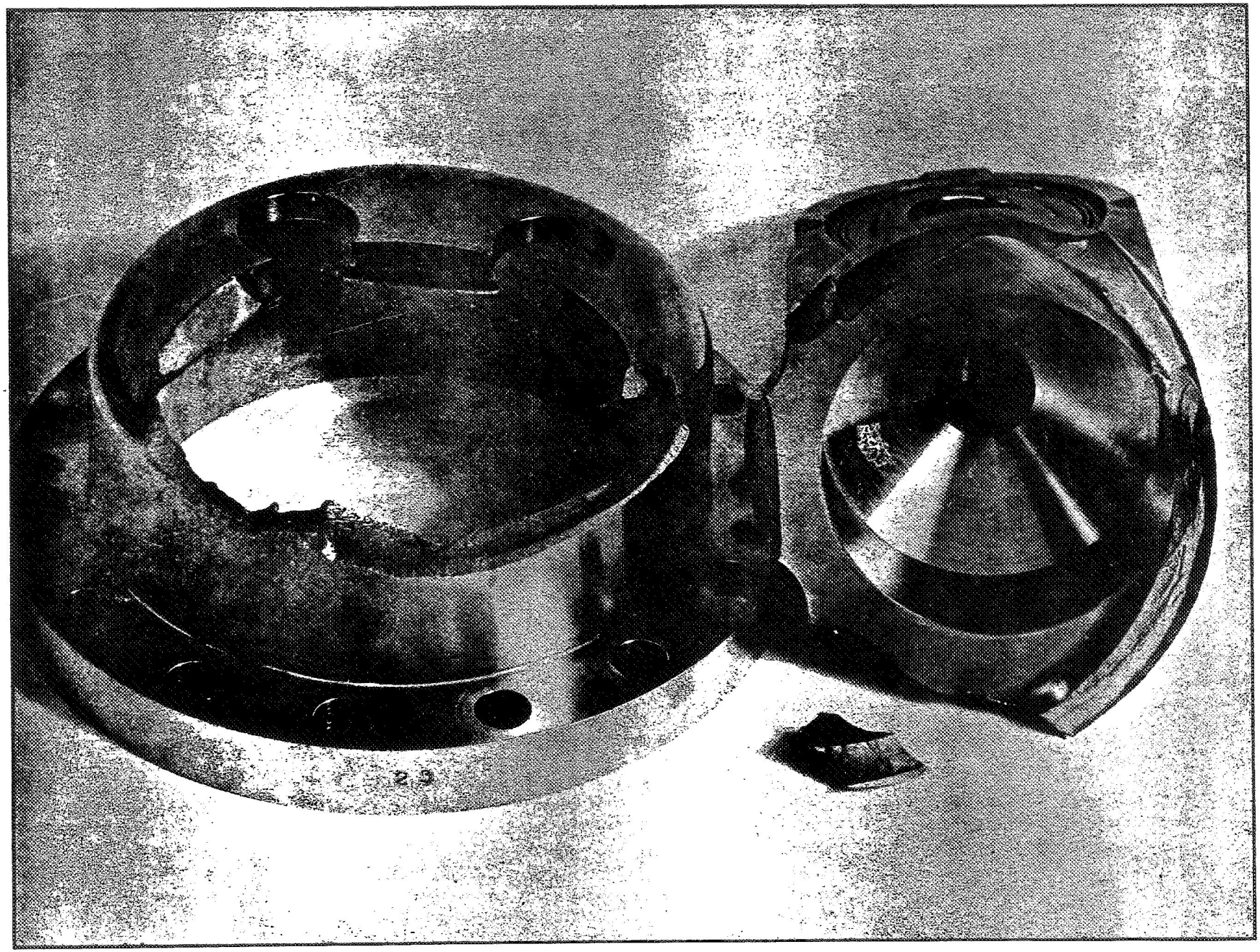


Figure 34. Failure of Tailstock Under Additional Cycling

2.2.9.3 (Continued)

As a result of the failure of test specimen No. 4, product improvement action, involving strengthening of the tailstock, was initiated by the vendor. An actuator, S/N 3, with the improved tailstock design, was successfully qualified in life-cycle testing by the vendor. The redesigned actuator was designated Douglas SCN 1A66248-505. Additionally, the -505 configuration is considered completely qualified by virtue of the fact that, except for the improved tailstock, the -505 configuration is identical to the -503 configuration.

2.2.10 Prefiltration Valve and Cylinder Bypass Valve

2.2.10.1 Requirements

2.2.10.1.1 Prefiltration Valve

There shall be no evidence of malfunction or external leakage when the prefiltration valve is subjected to the following operational cycles. With the cylinder outlet and return ports capped, apply 3,650-psig supply pressure and manually cycle the position level between open and bypass 25 times. Reduce the supply pressure to zero psig, remove the cap from the return port, and with the valve in the open position and the cylinder outlet port still capped, apply 3,650-psig supply pressure. Measure the leakage at the return port; internal leakage shall be determined during testing and there shall be no external leakage.

With the cylinder outlet port capped and the return port open to atmosphere, apply 3,650-psig supply pressure. With the valve in the bypass position, apply 0.75 $\pm$0.10 gpm flow at 170° $\pm$ 10°F from the supply inlet

to the return port. Measure the differential pressure across these ports. With the valve in the open position, measure the differential pressures across the supply-inlet and cylinder-outlet ports for fluid flow rates of 4, 8, and 12 gpm at 100°±10°F.

2.2.10.1.2 Cylinder Bypass Valve

There shall be no evidence of malfunction or external leakage when the cylinder bypass valve is subjected to the following operational cycles. Apply 150-psig supply pressure and manually cycle the valve open and closed 25 times. With one cylinder port to atmosphere, apply 3,650 psig to the other cylinder port and to the supply port. Leakage at the open cylinder port shall be determined during testing. With less than 200-psig supply pressure and with the valve in the bypass position, apply 2,000 psig at 100°±10°F across the two cylinder ports and measure the flow rate.

2.2.10.2 Procedure

2.2.10.2.1 Prefiltration Valve

The test specimens, A and B, were each installed in the test block as shown in figure 35. The cylinder outlet and return ports were capped, and 3,650-psig pressure was applied at the supply port. With pressure applied, it was impossible to move the valve handle; therefore, pressure was reduced to zero. Then, the valve was cycled manually 25 times.

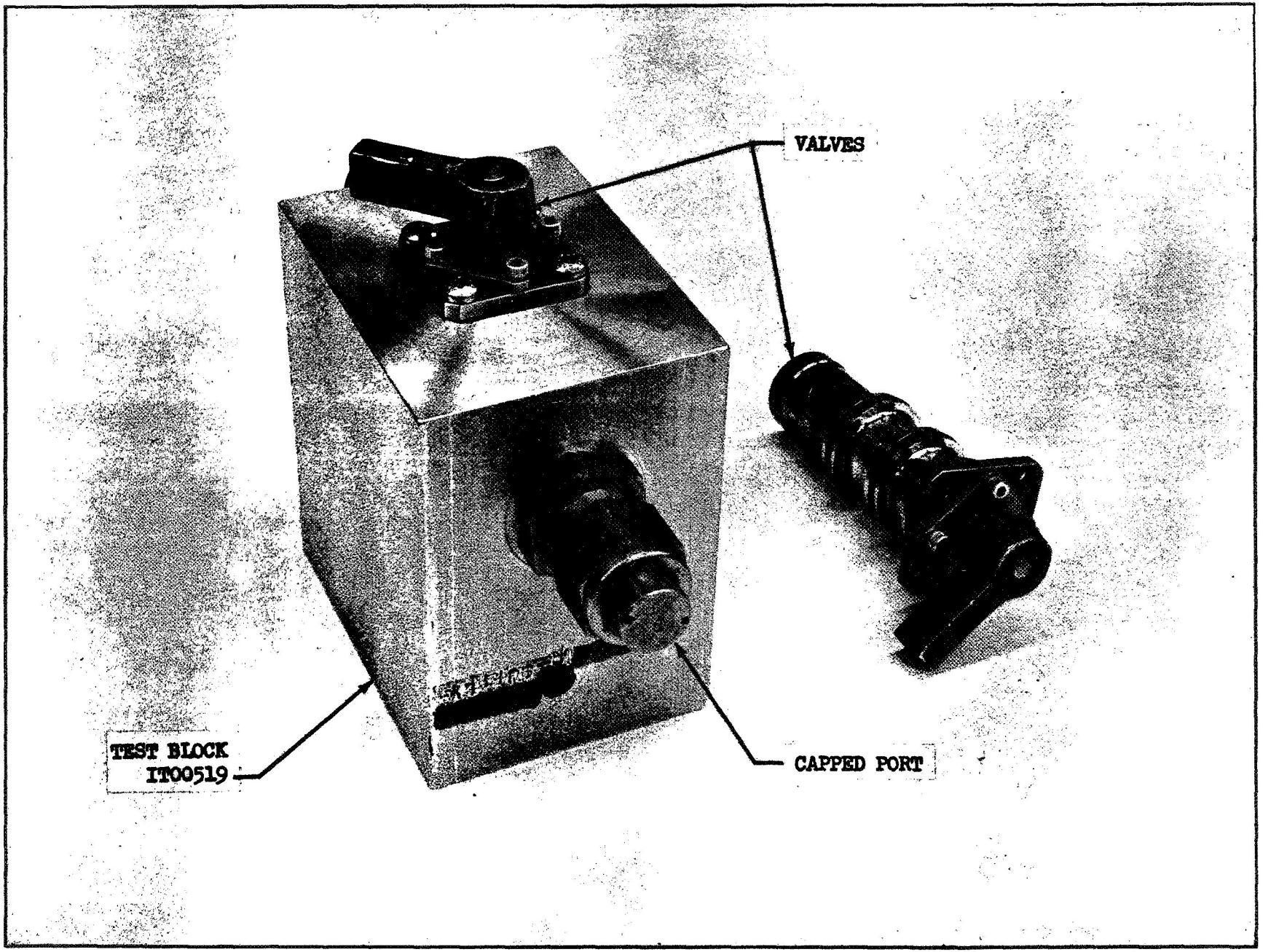


Figure 35. Prefiltration Valves and Test Block, Test Specimens A and B

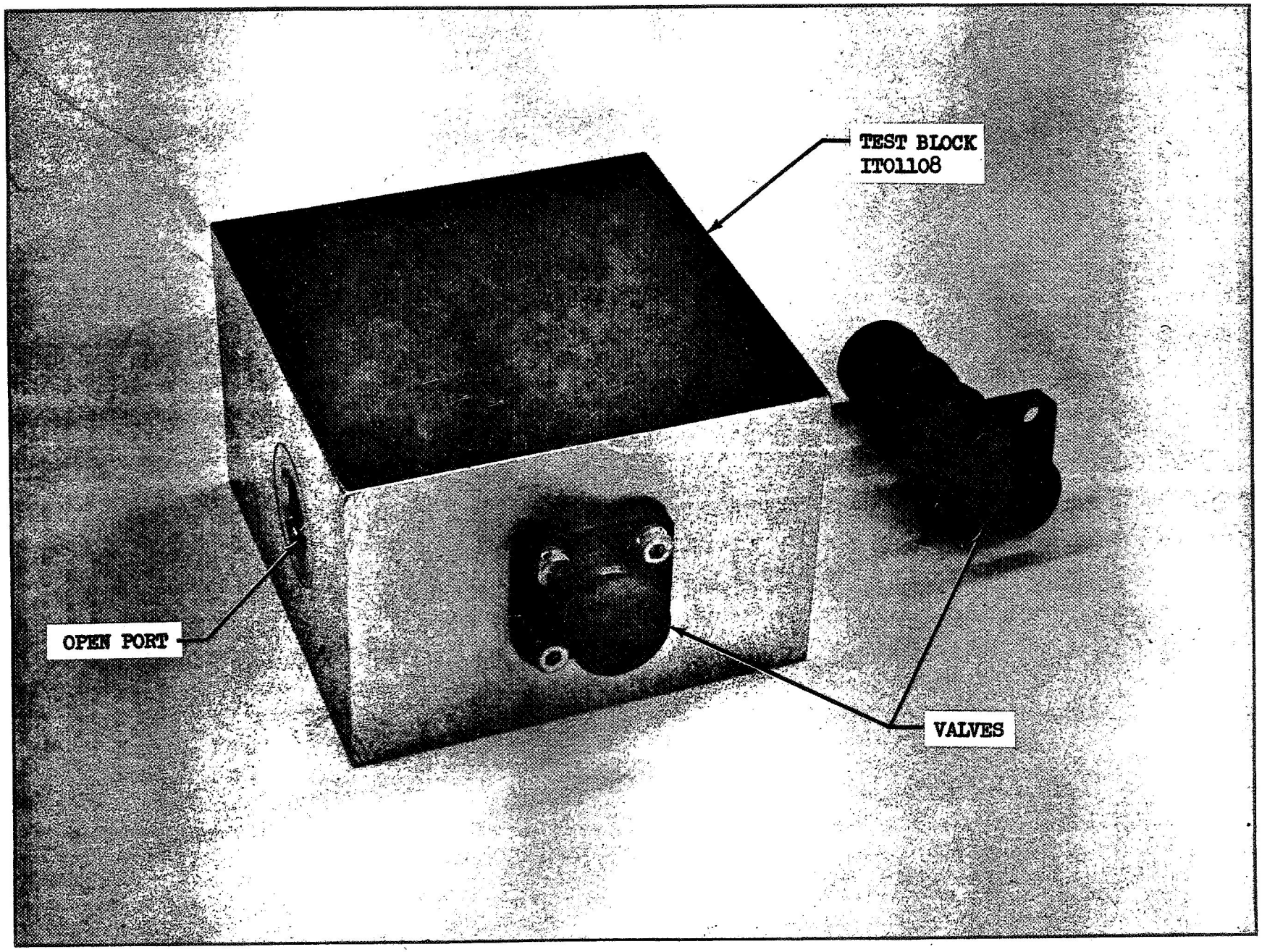


Figure 36. Cylinder Bypass Valves and Test Block, Test Specimens C and D

TABLE 11. PREFILTRATION VALVE TEST RESULTS

TEST DATE: 20 AUGUST 1965				
	RETURN PORT LEAKAGE		OUTLET PORT LEAKAGE	DIFFERENTIAL PRESSURE PSI
TEST SPECIMEN NO.	VALVE OPEN, CYLINDER OUTLET PORT CAPPED, SUPPLY PRESSURE APPLIED	VALVE OPEN, SUPPLY PORT CAPPED, PRESSURE AT OUTLET PORT	VALVE IN BYPASS, RETURN PORT CAPPED, SUPPLY PRESSURE APPLIED	CYLINDER OUTLET PORT CAPPED, 0.75±0.10 GPM FROM SUPPLY INLET TO RETURN PORT
A	NONE	NONE	63 drops/10 min.	1,280
B	NONE	NONE	80 drops/10 min.	1,080

2.2.10.3.2 Cylinder Bypass Valve

The cylinder bypass valve test results are listed in Table 12. Both test specimens performed satisfactorily. The flow rates through the cylinder ports with 2,000-psid differential pressure were 17.1 and 16.1 cis.

TABLE 12. CYLINDER BYPASS VALVE TEST RESULTS

TEST DATE: SEPTEMBER 1965		
	INTERNAL LEAKAGE	FLOW (CIS)
TEST SPECIMEN NO.	PRESSURE APPLIED AT SUPPLY PORT AND ONE CYLINDER PORT OPEN TO ATMOSPHERE	2,000 PSI DIFFERENTIAL PRESSURE ACROSS CYLINDER PORTS
C	4 drops/min.	17.1
D	5 drops/min.	16.1

2.2.11 Contamination

2.2.11.1 Requirements

Hydraulic-fluid cleanliness requirements for the actuator shall be as presented in NASA document MSFC-PROC-166A. These requirements apply to hydraulic systems prior to hookup of the test specimens and during operation of the test specimens. The required limits on particle size and quantity shall be:

	Number of Particles	
Size (Microns)	Return	Supply
10 to 25	2,150	1,340
26 to 50	530	210
51 to 100	60	28
100+ (including fibers)	10	3

2.2.11.2 Procedure

Hydraulic-fluid cleanliness was monitored throughout the temperature environmental response tests performed on test specimens No. 2, 3, and 4; refer to paragraph 2.2.1. The contamination information obtained in these tests represents the cleanliness performance of an actuator and a typical laboratory hydraulic system. The hydraulic system contained 150 gallons of MIL-5606A hydraulic fluid and was capable of providing a flow of 20 gpm at 5,000 psig over a temperature range of +300° to -65°F. Actuator operation consisted of frequency-response testing under simulated engine dynamic conditions. Frequent supply and return fluid samples were obtained, usually before and after each test run.

2.2.11.3 Results

A daily log and analysis of the fluid samples are presented in Tables 4-16 and 4-17, respectively. These results indicate a fairly steady particle distribution throughout the testing period. Particle quantities approximated the maximum requirements, with a tendency to be low in quantity for the smaller particles and high for the larger particles. The inlet and outlet samples show what appears to be a normal increase in particles from supply to return caused by passage through the actuator.

At no time, did the test specimen demonstrate contamination sensitivity, during this series of tests or any of the other qualification tests. All of the hydraulic systems in which the test specimen was tested were checked for initial cleanliness prior to actuator hookup and were kept clean by adequate fluid filtration throughout the testing.

2.3 Nonoperational Environmental Tests

2.3.1 High-Temperature Humidity

2.3.1.1 Requirements

There shall be no evidence of damage or maladjustment when the actuator assembly is exposed for 240 hours (10 cycles) to the following relative humidity cycle, using demineralized water with a 6.5 to 7.5 pH value at 77°F temperature and 150-fpm air velocity. Stabilize the actuator at 84°±16°F and 95-per cent relative humidity. Gradually raise the temperature from 84°±16° to 160°F over a 2-hour period while maintaining 95-per cent relative humidity. Maintain 160°F and 95-per cent humidity for 6

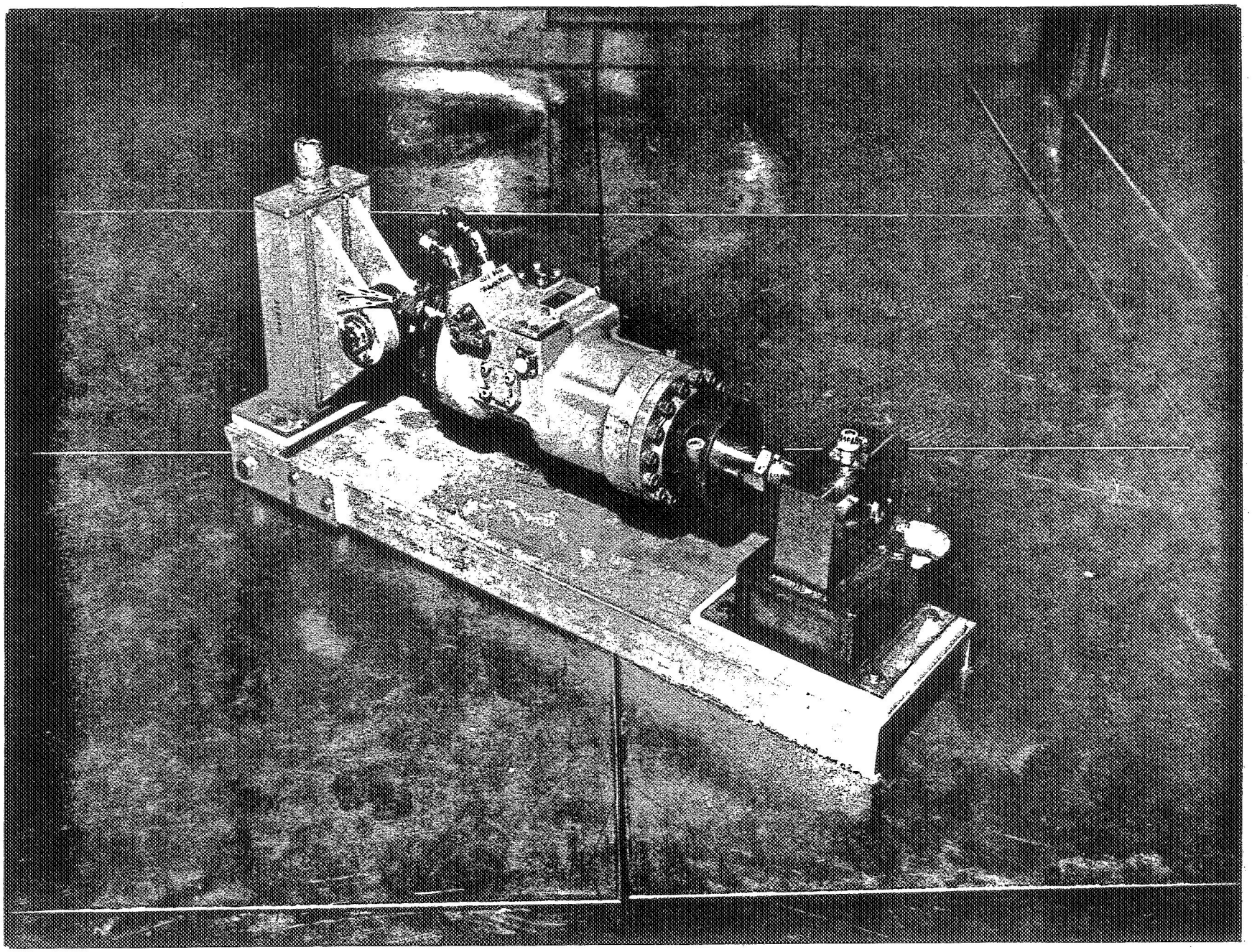


Figure 37. High-Temperature Humidity Test Setup

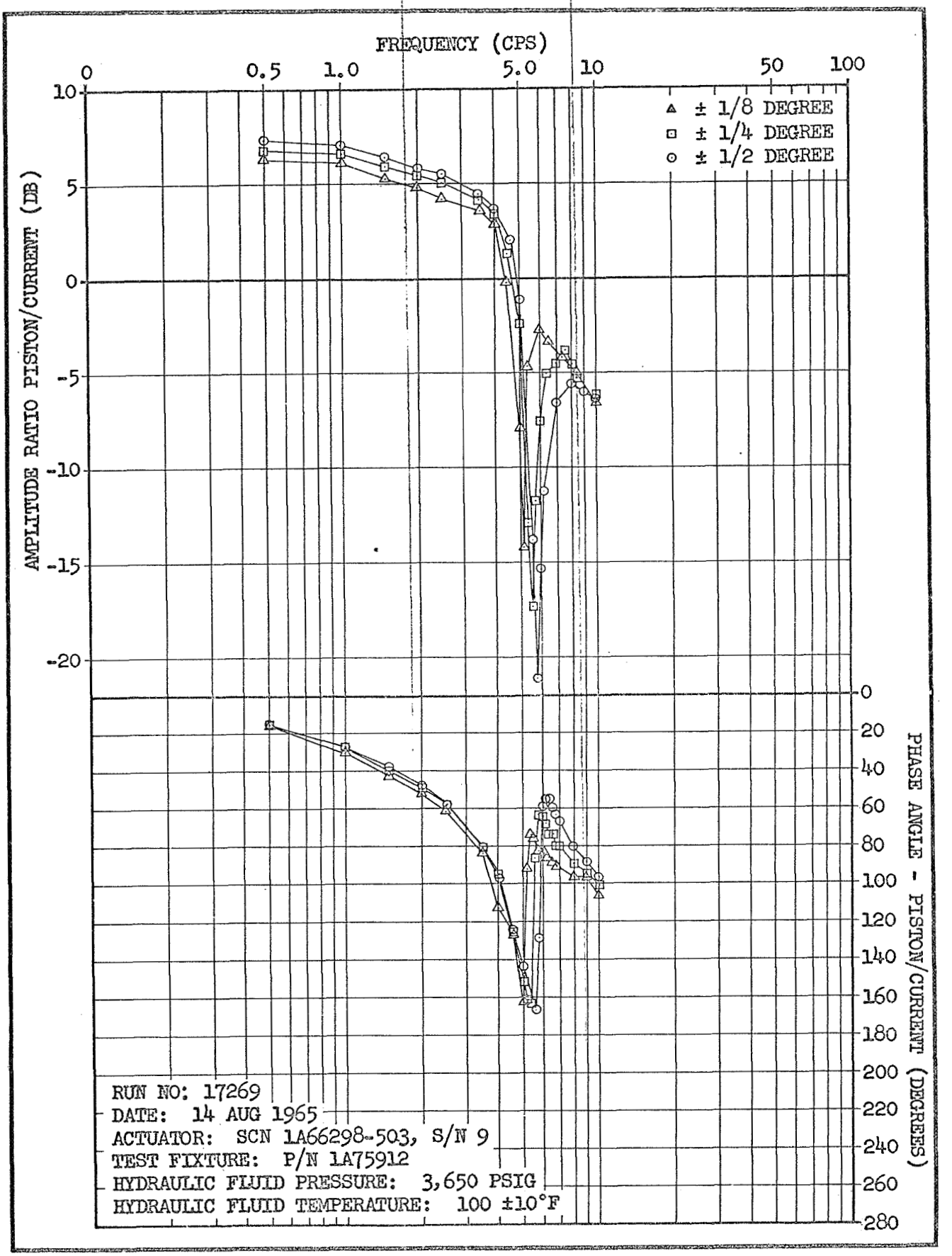


Chart 27. Post-Humidity Frequency Response, Piston/Current - Test Specimen No. 3

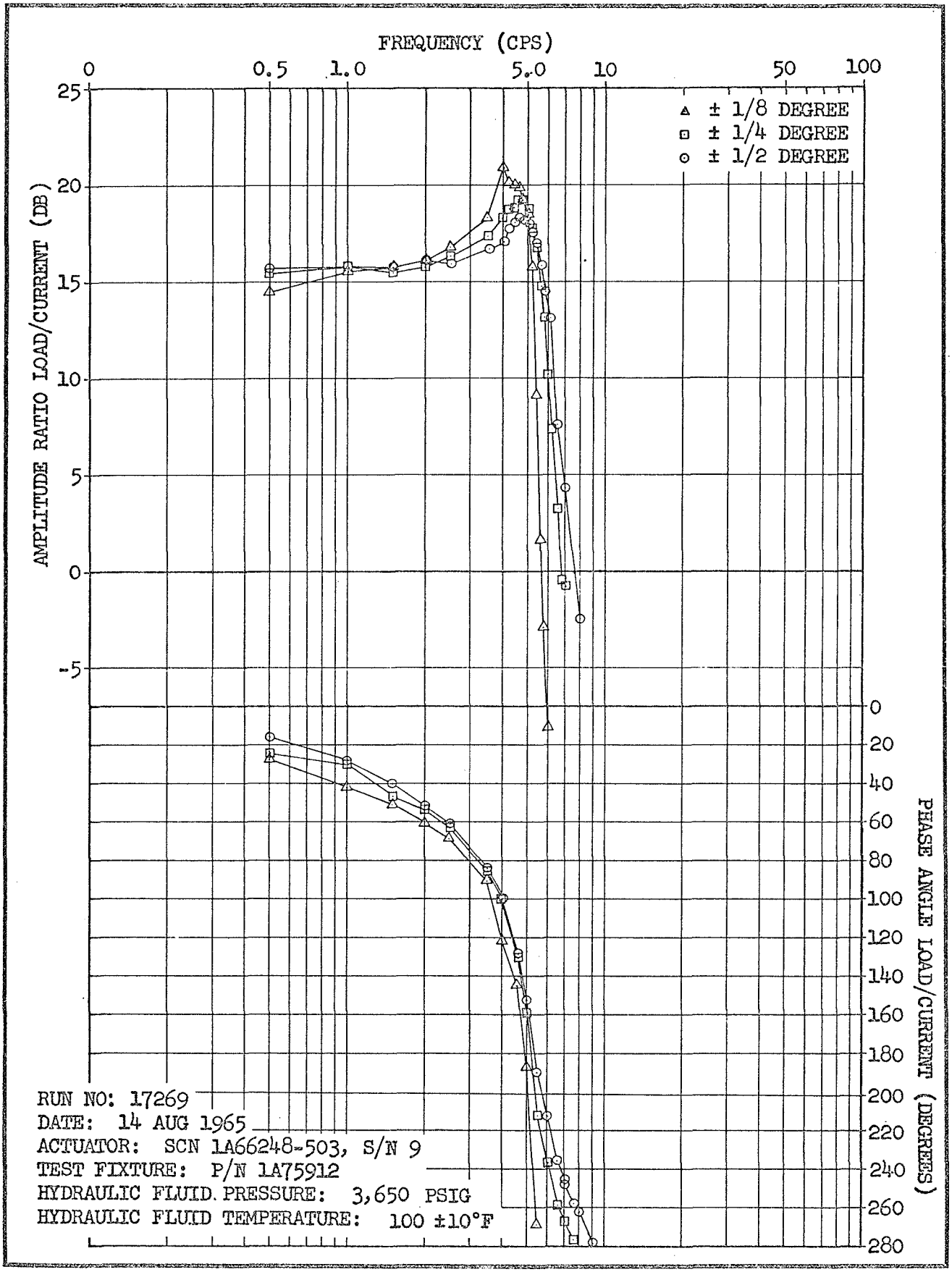


Chart 28. Post-Humidity Frequency Response, Load/Current - Test Specimen No. 3

2.3.1.3 (Continued)

Post-humidity visual inspection revealed a slight amount of corrosion on the electrical-connector welds and a few spots of corrosion on the rod end. This slight amount of corrosion, occurring during the 240-hour test period, is considered normal for this type of test and did not impair actuator performance in any way. Post-test performance checks indicated that the actuator dynamic response was unaffected by the applied humidity environment.

2.3.2 High-Temperature Burst

2.3.2.1 Requirements

The test specimen shall be heat-soaked at +275°±5°F for 5-hours minimum until the thermocouples on the test specimen indicate temperature stabilization. A 5,475-psig pressure shall be applied to the return port at a maximum rate of 25,000 psi per minute and held for 2 minutes. After reducing the pressure to zero, 9,130-psig pressure shall be applied to the actuator high-pressure port, leaving the return port open to drain leakage. There shall be no internal leakage at either of these pressures; permanent set is allowable. After 9,130 psig is reached and held for 2 minutes, the pressure shall be increased in increments of 2,000 psig, holding each new pressure for 1 minute, until rupture occurs.

2.3.2.2 Procedure

The burst test was performed on test specimen No. 4 and differed slightly from the procedure called out in the requirements. Pressurization of the return side separately (to 5,474 psig) was omitted. The supply, cylinder, and return ports were pressurized simultaneously.

To prepare the test specimen for testing, the differential-pressure transducer was removed and was replaced by an adapter block which allowed pressurization of all hydraulic cavities. Both cylinder ports were attached to the supply-port fitting. The return-port fitting was capped. The titanium tailstock, having no significance in this test, was removed. The actuator was filled and bled. This piston was positioned in the neutral position. Three rosette strain gages were installed on the external circumference of the actuator as shown in figure 38. This arrangement, which constituted a deviation from the TCD requirements, was made for purposes of expediency. However, despite the deviation, the strain gage arrangement was more severe than the original test.

The prepared actuator was placed in a cylindrical burst cannister which in turn was installed in the thermal chamber. A hydraulic pressure line was routed from the actuator supply port to a hydraulic power unit. The strain gage leads were attached to an oscillograph.

The test specimen was heat-soaked for 16 hours at +275°F and no pressure. At the end of this period, the strain gages were calibrated in preparation for the burst test. Then, the hydraulic pressure was slowly increased until the part ruptured. The test dates were September 7 and 8, 1965.

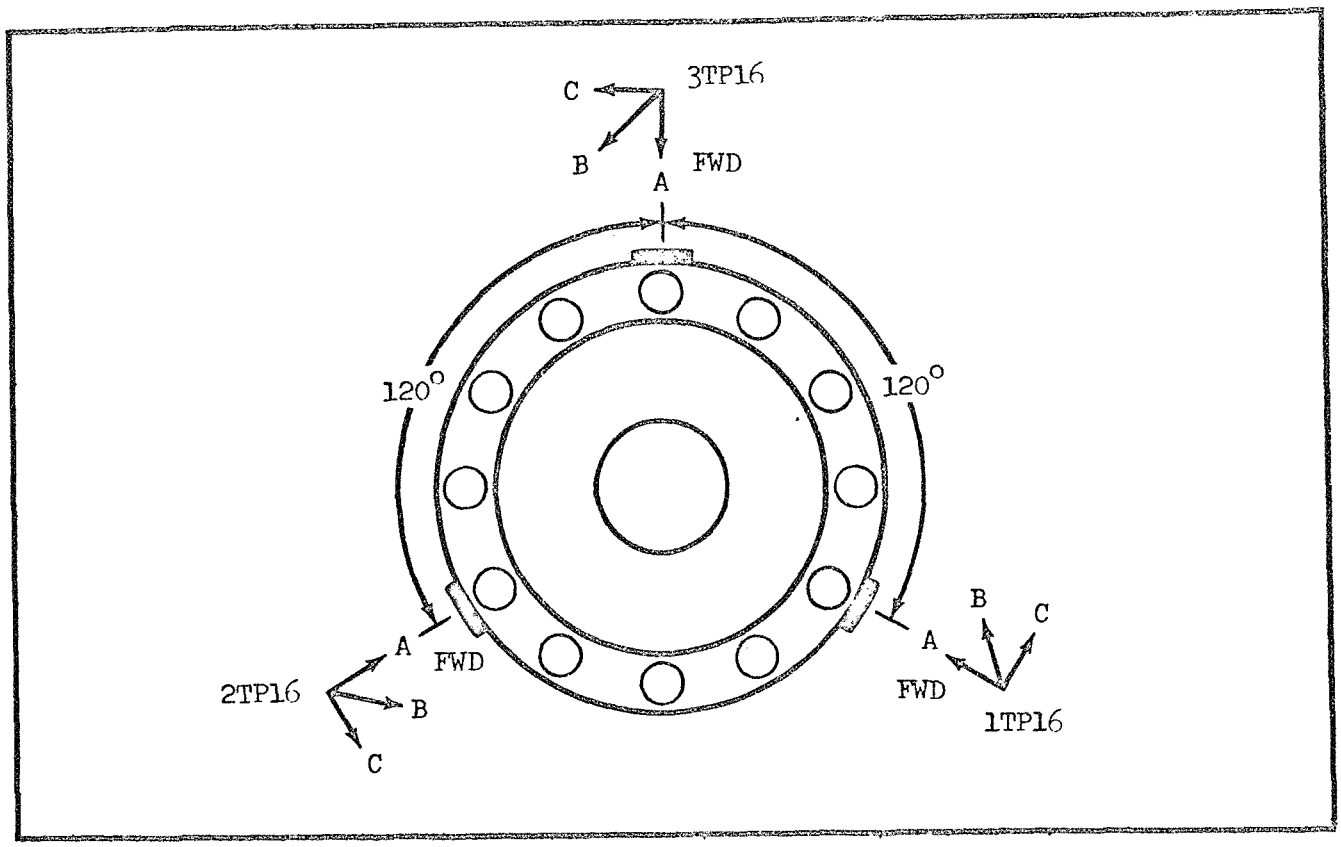


Figure 38. High-Temperature Burst Strain Gage Locations

2.3.2.3 Results

Rupture of the aluminum housing from internal hydraulic pressure at +275°F occurred at an indicated gage pressure of 9,800 psig. The pressure-transducer oscillograph recording indicated 9,711 psig. The design burst point was 9,130 psig. Pressures of 5,500 and 9,100 psig were held for 2 minutes each before going to burst pressure. There was a slight amount of leakage at 9,100 psig. The ruptured actuator is shown in figures 39, 40, and 41. As the photos show, the filter cover was pushed up considerably. Removal of the servovalve revealed a slight extrusion of the mounting-face O-rings. Strain values for four loading conditions of the three rosettes are listed in Table 13.

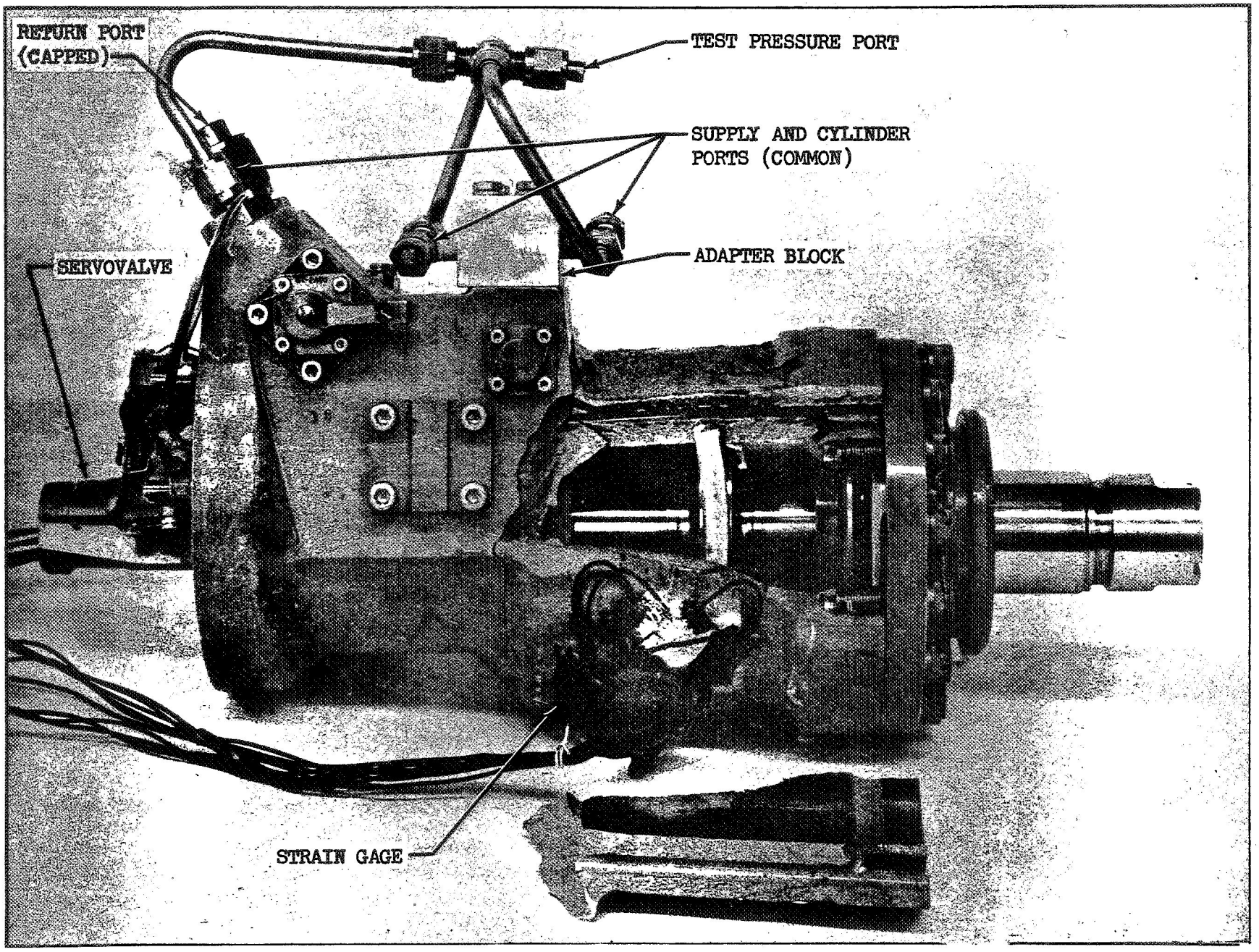


Figure 39. Ruptured Actuator, Showing Modified Hydraulic Circuit

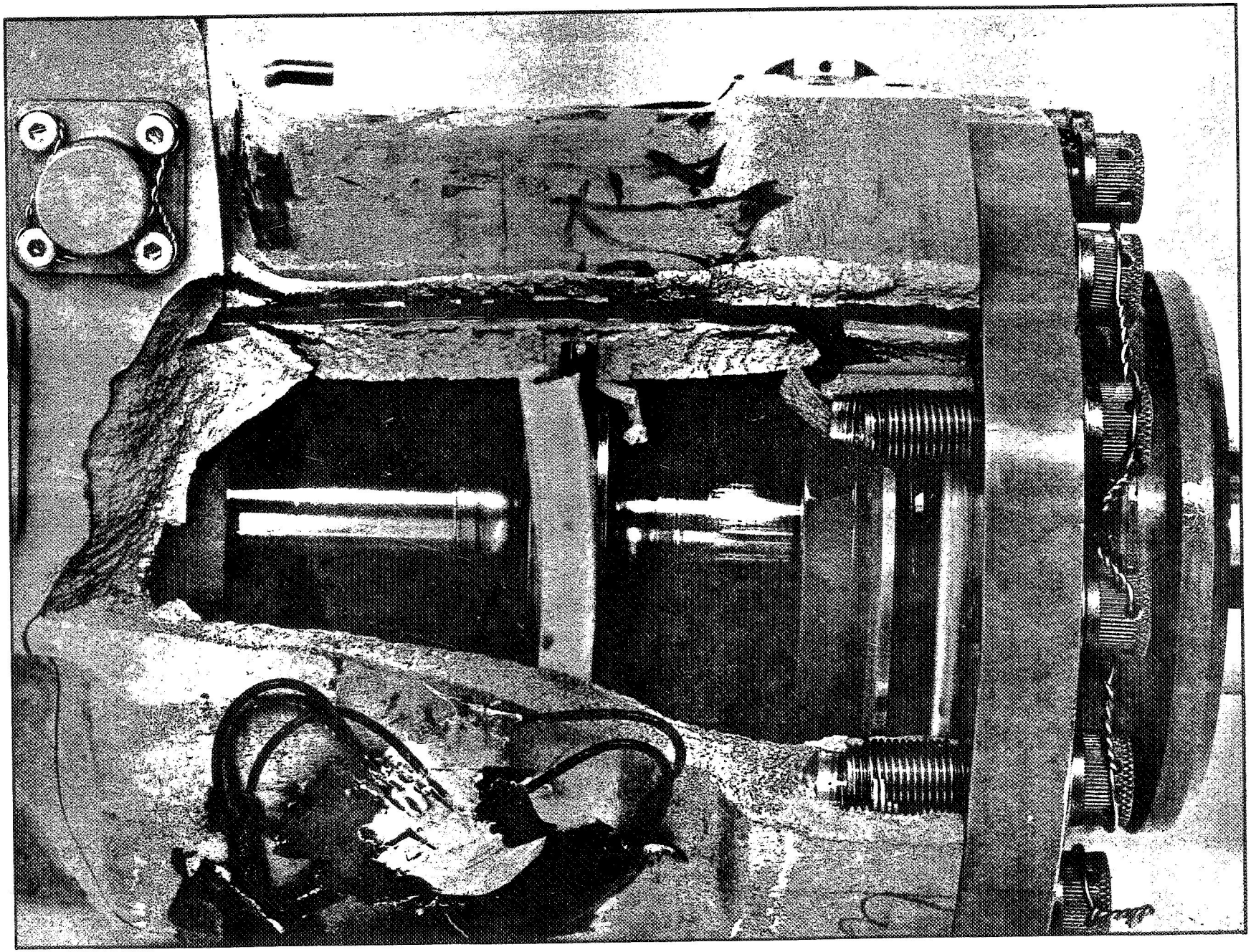


Figure 40. Ruptured Actuator, Interior View

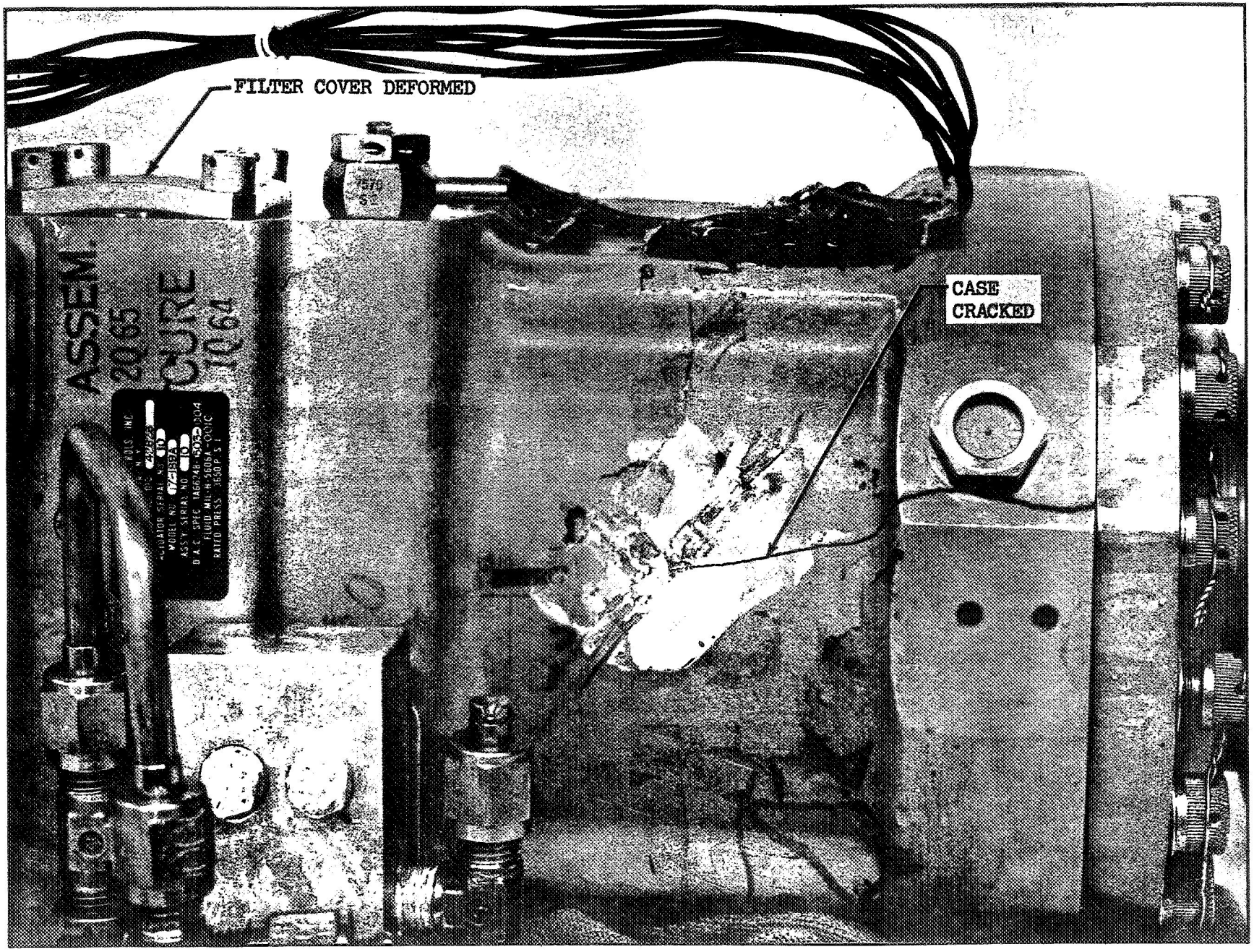


Figure 41. Ruptured Actuator, Additional Damage

TABLE 13. HIGH-TEMPERATURE BURST, TEST SPECIMEN NO. 4

STRAIN DIRECTION	STRAIN -- IN./IN.			
	PRESSURE LOADS			
	39.8 PSIG	5,532 PSIG	8,832 PSIG	9,711 PSIG
1TP16A	0.387422-04	0.736102-03	0.112352-02	0.127849-02
1TP16B	0.371255-04	0.148502-02	0.241316-02	0.271016-02
1TP16C	0.781245-04	0.226561-02	0.367185-02	0.421873-02
2TP16A	0.389017-04	0.816936-03	0.128376-02	0.143936-02
2TP16B	0.769020-04	0.169184-02	0.276847-02	0.315298-02
2TP16C	0.116705-03	0.241191-02	0.392907-02	0.443480-02
3TP16A	0.765404-04	0.841944-03	0.122465-02	0.141600-02
3TP16B	0.000000-00	0.135056-02	0.217591-02	0.243852-02
3TP16C	0.788443-04	0.216822-02	0.350857-02	0.394221-02

3. CONCLUSION

Based upon the qualification test results presented in this report, the conclusion of the Douglas Aircraft Company, Inc., is that the hydraulic actuator assemblies, SCN 1A66248-503, manufactured by Moog Servocontrols, Inc., successfully met all but one of the test requirements described in section 2 of this document.

The one failure was a crack in the titanium tailstock of test specimen No. 4 during the life-cycle test. The weakness was corrected by strengthening the tailstock, and the Douglas configuration was changed from SCN 1A66248-503 to SCN 1A66248-505. The vendor, Moog Servocontrols, Inc., has successfully life-cycle-tested a -505 test specimen.

Consequently, the Douglas Aircraft Company, Inc., concludes that the hydraulic actuator assembly, SCN 1A66248-505, is qualified for its intended use in the flight control hydraulic system of the Saturn S-IVB stage. This conclusion is based on the fact that the 1A66248-505 configuration is identical to the 1A66248-503 configuration, except for the strengthened tailstock. Since all other features of the actuator assembly were successfully tested in the Douglas testing of the -503 configuration, and since the tailstock was successfully tested in the Moog testing of the -505 configuration, it is correct to conclude that the -505 configuration has successfully passed all of the qualification test requirements.

During the qualification testing, the following deviations from the test requirements were encountered and corrective actions were taken as noted.

In the checkout preceding the high-temperature vibration test, specimen No. 2 failed from the combination of an accidental application of hydraulic temperature exceeding +275°F (approximately +325°F) and a poor potting job on the valve connector which allowed the wires to pull loose.

3. (Continued)

As the failure was considered unique to this test specimen, no corrective action was deemed necessary for production actuators. Specimen No. 3 was substituted for No. 2 for the high-temperature vibration test.

Test specimen No. 3 successfully completed the high-temperature vibration test. However, the post-vibration frequency response revealed high-amplitude peaking for the load/current response. This indicated a reduction in system dynamic dampening, possibly within the DP-F network. Test specimen No. 3 was returned to the vendor for analysis. Since the high-amplitude peaking exceeded the maximum requirement by only a small amount, no corrective action or additional testing was deemed necessary to qualify the actuator.

Table 4-19 is a final complete check on actuator -503 (test specimen No. 4) after all tests had been completed and prior to the burst test. Because of the failures experienced with test specimens No. 2 and 3, explained earlier, these parts were returned to the vendor for analysis; therefore, the final performance check could be run on test specimen No. 4 only.

APPENDIX 1

1. TEST PARTS AND EQUIPMENT

1.1 Test Specimen

The hydraulic-actuator qualification tests were begun on three test specimens of the SCN 1A66248-501 configuration. The specimen actuators were manufactured by Moog Servocontrols, Inc., East Aurora, New York and carried Moog serial numbers 8, 9, and 10. All three of these actuators were returned to the vendor for rework of the electrical connectors and for other improvements. When testing resumed, the test specimens carried the same serial numbers but were renumbered to the Douglas -503 configuration, because of improvements and changes. As explained in paragraph 1.4, the test specimens, Douglas SCN 1A66248-503, were numbered 2, 3, and 4 for S/N 8, 9, and 10, respectively.

Separate tests were run on specimens of the prefiltration and cylinder bypass valves. The prefiltration valve test specimens are designated A and B; the cylinder bypass valves are designated C and D. There were no serial numbers on any of the four valves.

The following tabulation is a breakdown of the individual actuator test assignments by specimen number and serial number.

Specimen No.	Serial No.	Tests
2	8	Acceptance Thermal Vacuum Resistance to Heat Flow Room-Temperature Vibration on specimen No. 2 of the -501 configuration

1.1 (Continued)

Specimen No.	Serial No.	Tests
3	9	Acceptance Temperature Environmental Response Room-Temperature Vibration High-Temperature Vibration Acceleration Mechanical Shock Electromagnetic Interference Life Cycle High-Temperature Humidity
4	10	Acceptance Room-Temperature Vibration Life Cycle High-Temperature Burst Temperature Environmental Response

1.2 Test Equipment

1.2.1 Instrumentation

Unit	Company	Model	Range	S/N
DSV-4B Servo Control Panel	Douglas	1T05779	-----	---
Flow Meter	Servac	-----	-----	---
DC Voltmeter	Hewlett Packard	412A	-----	---
Potentiometer Test Set and Dial Indicator		X-537354-C	-----	---
Insulation Breakdown Tester	Douglas	N/A	-----	---
Dual-Channel Servo Control Unit	Douglas	50462 (1T03445)	-----	---
Automatic Servo Test System	Ramo	RW-300	-----	---

Unit	Company	Model	Range	S/N
Low-Frequency Function Generator	Hewlett Packard	202A	-----	---
Actuator Differential-Pressure Transducer	Servonics	2131-0501	±6,000 psig, 5,000 ohms, 10 ma at 70°F	1037
Actuator Cylinder-Temperature Transducer (Probe)	Winsco	2606-519	-----	149
DSV-4B Single-Channel Servo Controller (NASA Breadboard Amplifier)	-------	49376 (Douglas)	-----	---
Fluid Flow Transducer	Foxboro	CM-65940	-----	---
Digital Counter	Berkeley	EPUT 554B	-----	---
Temperature Controller	West Instr.	Guardsman J	-----	---
Pressure Transducer	Statham	P146G	-----	---
Pressure Transducer	Servonics	2071-0111	-----	---
Vacuum Gage Readout	F. J. Cooke	-----	-----	---
Vacuum Gage Readout	Varian	-----	-----	---
RIFI Meter	Stoddart	NM22A	-----	384-40
RIFI Meter	Stoddart	NM30A	-----	337-46
Dial Indicators (2)	Ames	-----	Least count: 0.001 inch	---
Strain Gages (3)	-------	Rosette	-----	---

1.2.2 Electrical and Recording

Unit	Company	Model	Range	S/N
Resistance Bridge	Leeds & Northrup	4775	-----	---
Oscillograph	Minneapolis Honeywell	1108	-----	---
Oscilloscope	Hewlett Packard	13013	-----	---
Recording Oscillograph	CEC	Datarite 5-129-P4	-----	---
Oscilloscope	Tektronix	Type 551	-----	---
Temperature Recorder	Minneapolis Honeywell	Brown 156 x 62 - P12 HB	-----	---
DC Power Supply	Kepco	CR60-0.5M	-----	---
Oscilloscope	Hughes	Memoscope 104	-----	---
Recording Oscillograph	CEC	7-180-9579 (NASA)	-----	---
Temperature Recorder	Leeds & Northrup	Speedomax G	-----	---
Digital Recorder	Hewlett Packard	Dymec H25 562A	-----	---
Frequency/Voltage Converter	Vidar	923	-----	---
Inverter	Leland Airborn	SE-16-300	-----	---
Low-Frequency Oscillator	Hewlett Packard	18-064-CML-2746 (Douglas)	-----	---
Power Supply	Trygon	HR40-5A	-----	---
Power Supply	Electro	NFB	-----	---
Precision Power Supply	Christie	MH36-100KKGG24L	-----	---
Balance Box	GFE	NASA 7-1	-----	---
Amplifier	Douglas	P/N 1A93140	-----	---

Unit	Company	Model	Range	S/N
Amplifier	NASA	P/N 50M37393	-----	---
Thermocouples	Revere	Copper Constantan	-----	---
Temperature Recorder	Minneapolis Honeywell	Brown RY 15306836 -24-03-2- 000-030-10	-100° to -350°F	---
Temperature Recorder	Minneapolis Honeywell	Brown 153 X 62- P12-II-III-50	-----	---
Signal Generator	Hewlett Packard	200CD	-----	24840
Signal Generator	Hewlett Packard	606A	-----	038-01842
Signal Generator	Hewlett Packard	608D	-----	369-04939
Line Stabilization Networks (6)	Stoddart	91221-1	-----	---
50-Ohm Terminations (6)	Stoddart	90514-2	----	---

1.2.3 Facilities

Unit	Company	Model	Range
Hydraulic Power Units (2)	Douglas	No. 9 No. 105	(Used for Acceptance Tests)
Automatic Particle Counter	HIAC	PC-202	-----
Single-Axis Engine-Load Simulator	Douglas	P/N 1A75912	1,450 slug ft^2 11.975-inch moment arm
Environmental Chamber	Douglas	No. 12	+275° to -100°F (Environmental Response Test)

1.2.3 (Continued)

Unit	Company	Model	Range
Hydraulic System System	Douglas	No. 1	+275° to -100°F Fluid Temp. (Environmental Response Test)
Shaker and Automatic Data Handling System	Ling	C-249	0 to 30,000 g-lbs
Electromechanical Vibration Shaker	Ling	L-249	-----
Hydraulic Test Stand	Auto Controls	2849	5,000 psig at 20 gpm
Large Centrifuge	Rucker	58-3189 Type RCT-2A	0 to 70,000 g-lbs
Hydraulic Pumping System	Rucker (Douglas, in Unit 143)	-----	-----
Shock Tester	Hyge	-----	-----
Microedge Filter	Bendix	031618	-----
Space Simulation Chamber	Douglas	C-1	-----
Hydraulic Test Cart	Auto Controls	610456 (Douglas)	-----
Liquid Nitrogen Cart	Douglas	-----	-----
Hydraulic Load System	Douglas	-----	(For Life Cycle Test)
Environmental Chamber	Douglas	No. 13	(Humidity Test)
Thermal Chamber	Conrad	No. 6	(Burst Test)
Hydraulic Power Unit	Sprague	S404 (No. 68)	(Burst Test)

1.2.4 Fixtures

Unit	Company	Model	Range
Acceptance Test Adapter Block	Douglas	1T12158	-----
Vibration Test Holding Fixture	Douglas	1B09567	-----
High-Temperature Vibration Test Support Fixture	Douglas	1T08946-1	378 lb
Interface Support Fixture	Douglas	1T08822-501	300 lb
Acceleration Test Fixture	Douglas	1B09566	-----
Environmental Holding Fixture	Douglas	1T03424	(Humidity and Resistance to Heat Flow)
Life-Cyle Test Fixture (Linear Load)	Douglas	1B09565	-----
Prefiltration Valve Test Block	Douglas	1T00519	-----
Cylinder Bypass Valve Test Block	Douglas	1T01108	-----
Holding Fixture	Douglas	1B07567	-----

APPENDIX 2

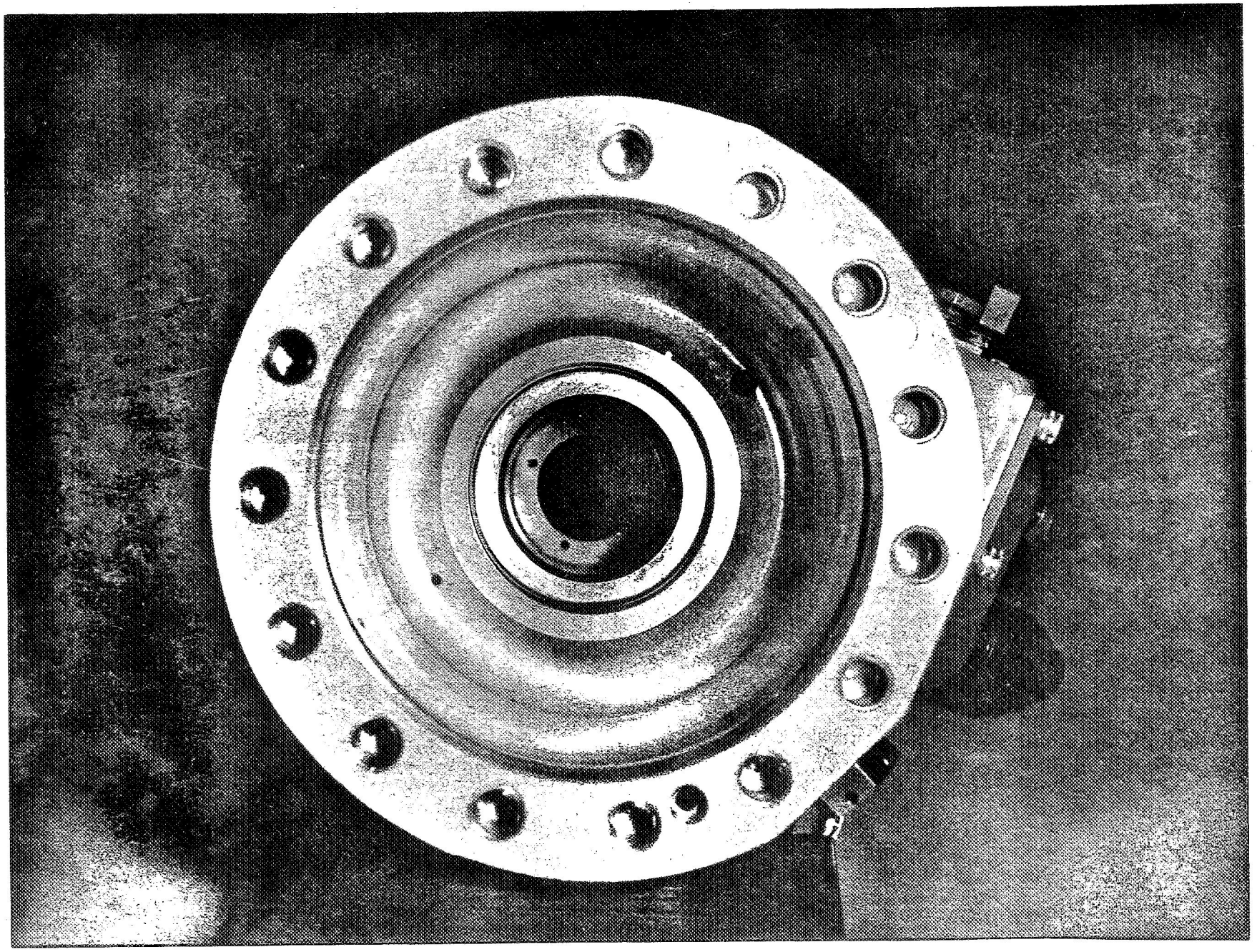


Figure 2-1. Actuator Cylinder Bore

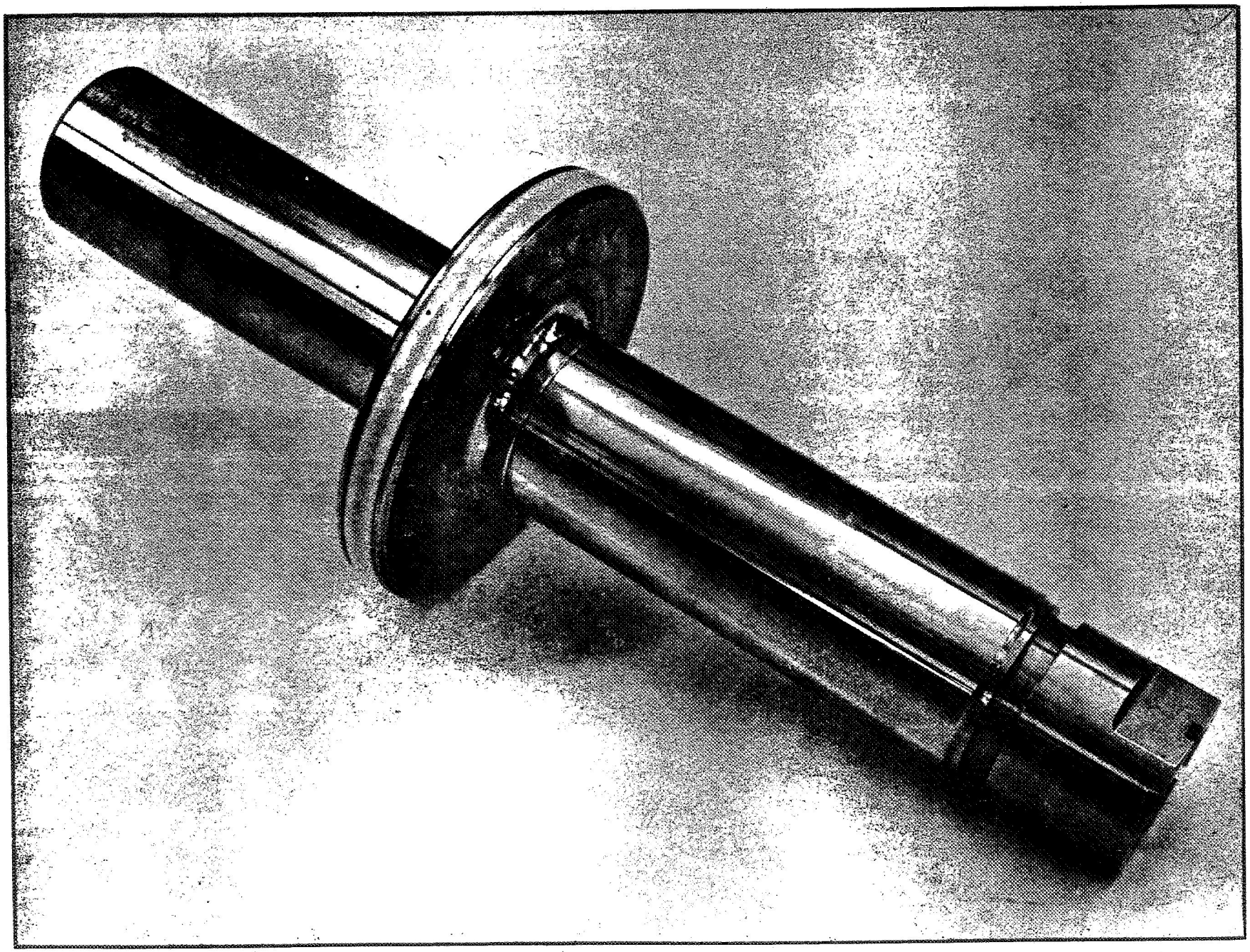


Figure 2-2. Actuator Piston

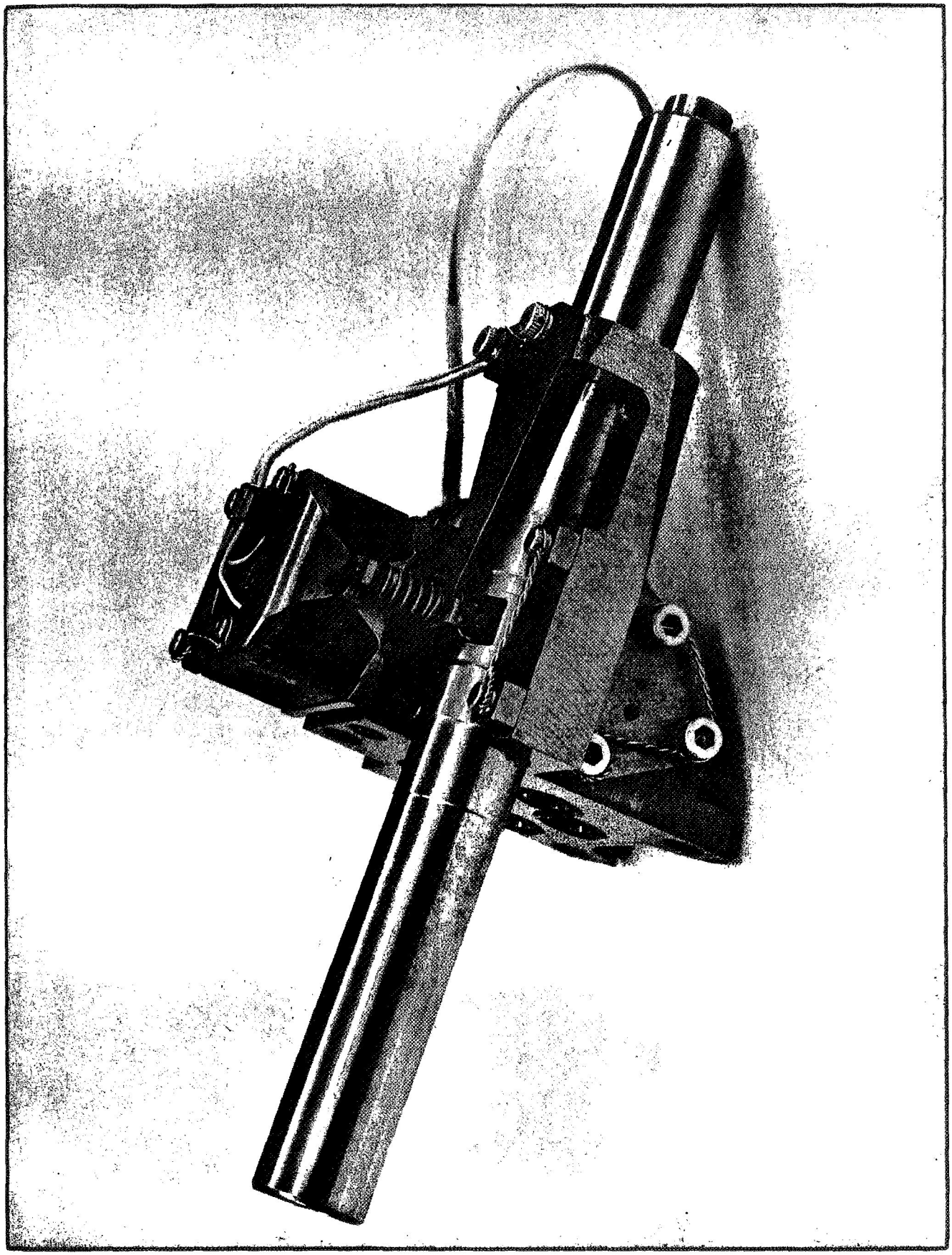


Figure 2-3. Actuator Servovalve

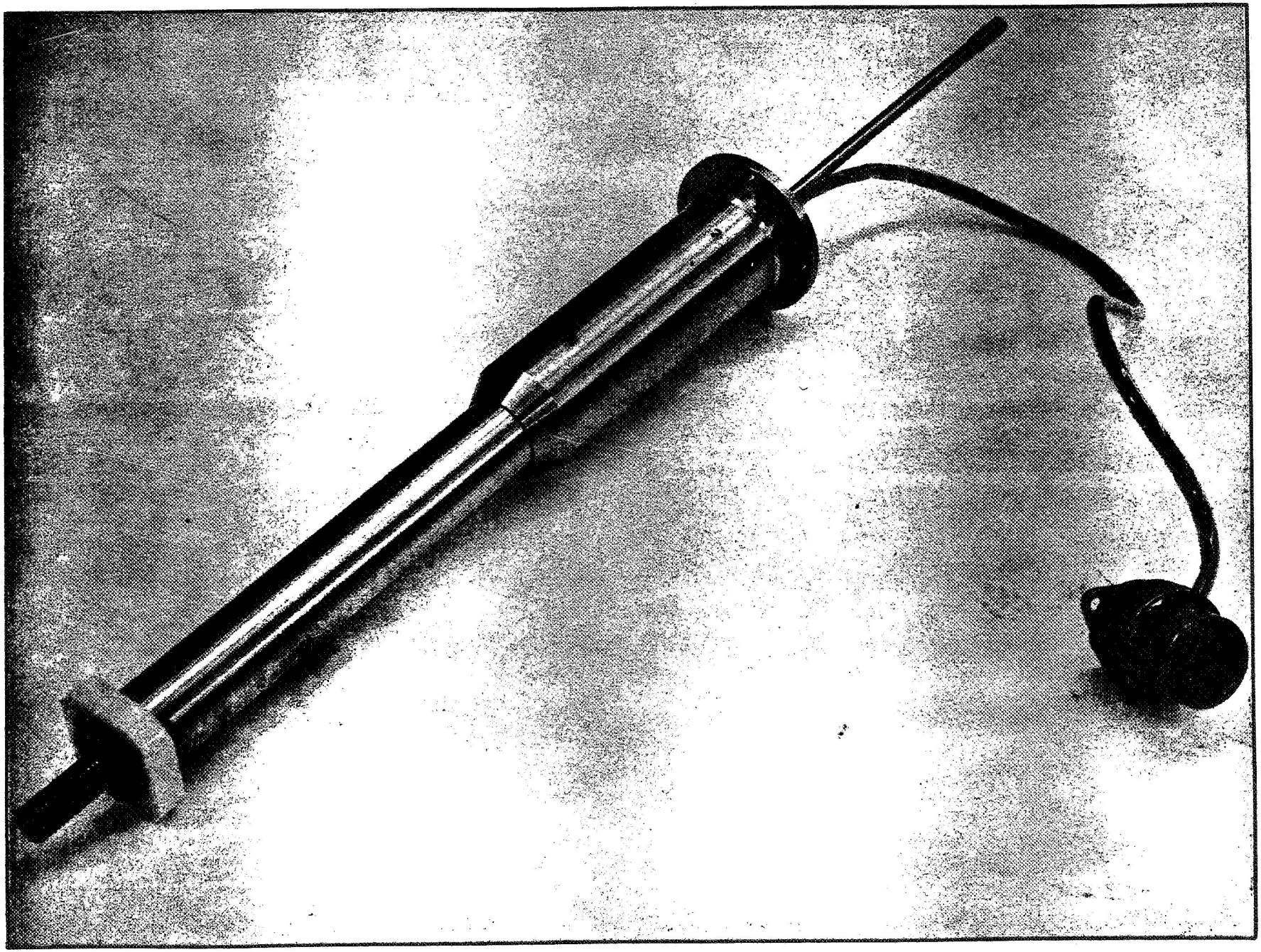


Figure 2-4. Actuator Piston Position Potentiometer

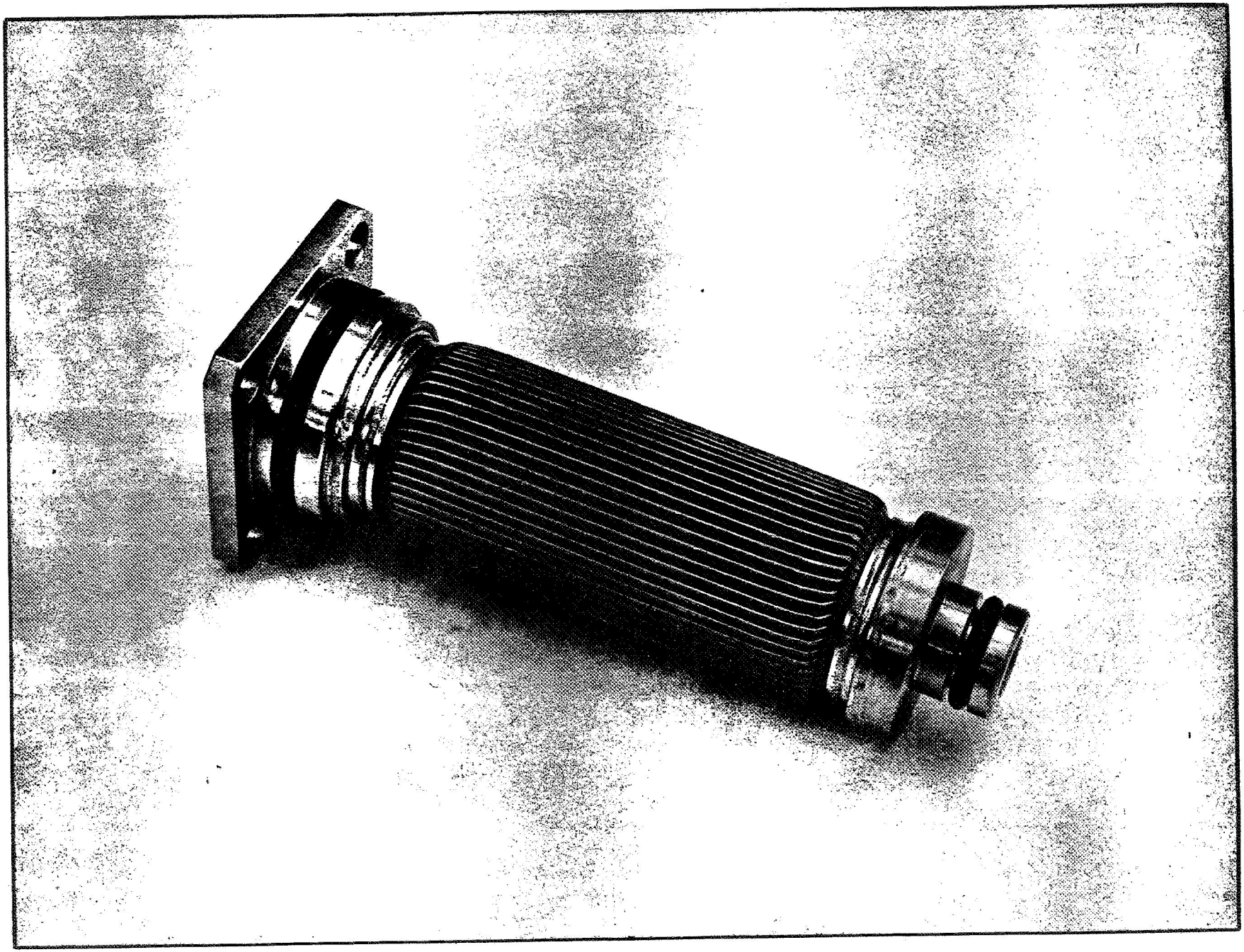


Figure 2-5. Actuator Fluid Filter

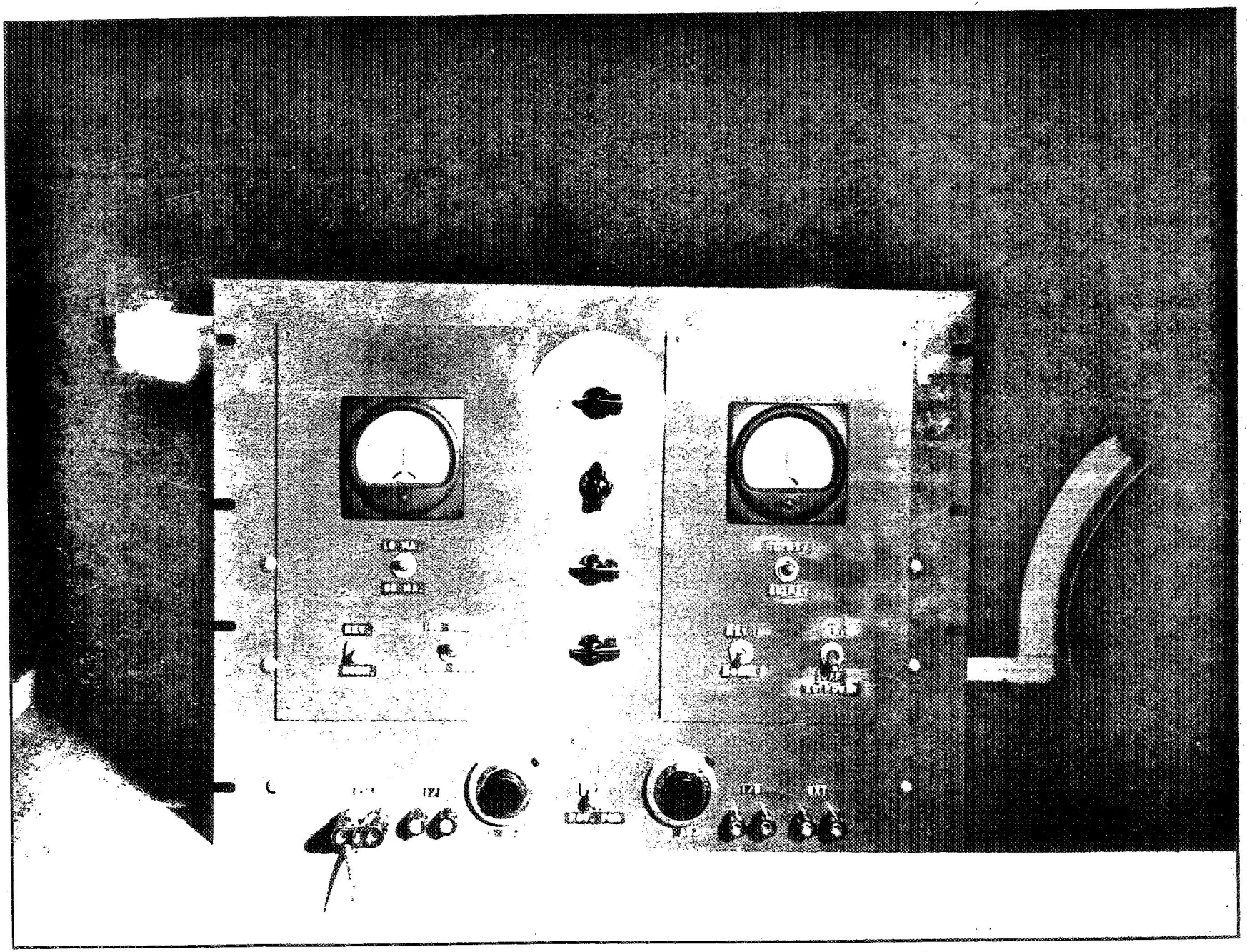


Figure 2-6. Dual-Channel Servo Control Unit

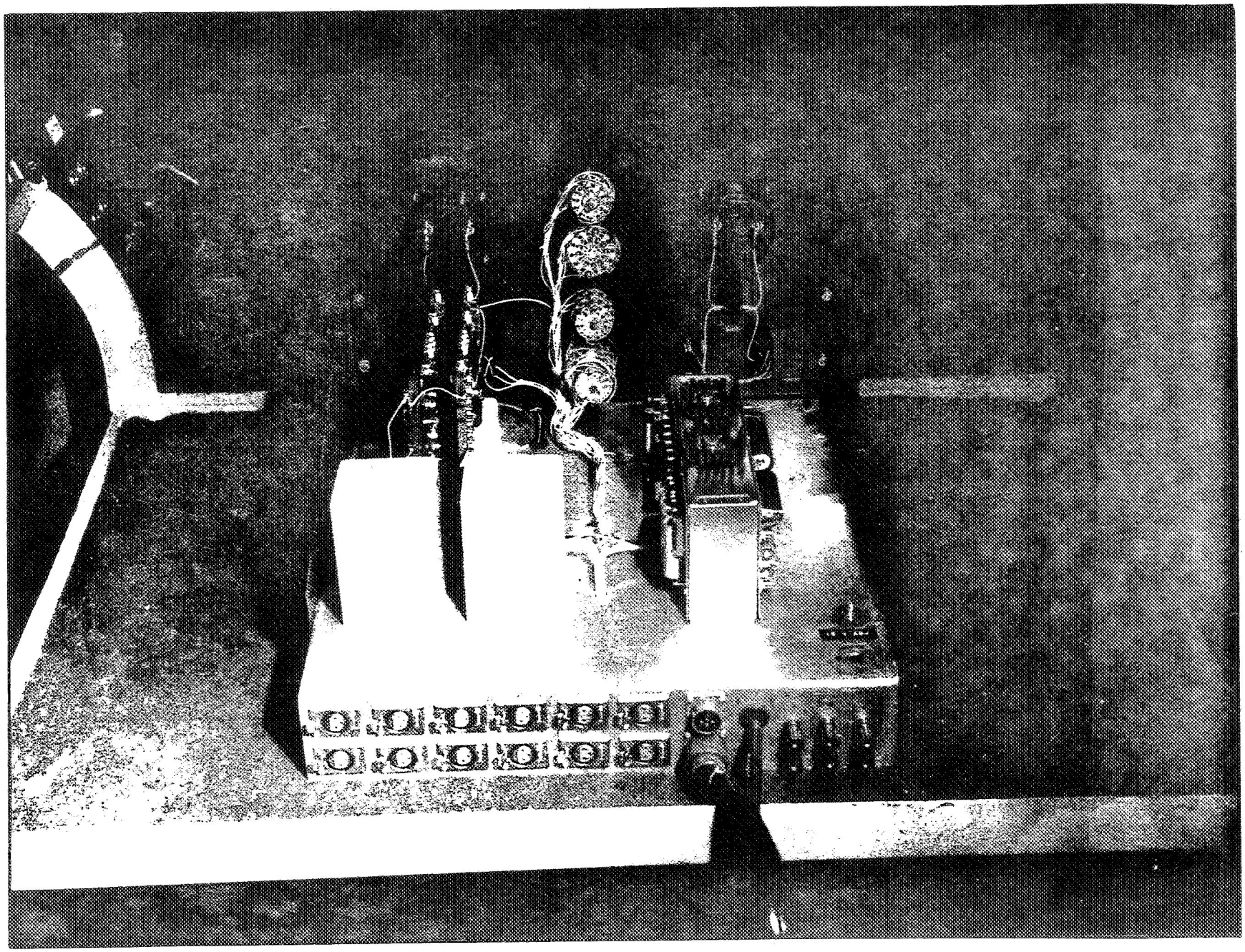


Figure 2-7. Servo Control Unit, Interior View

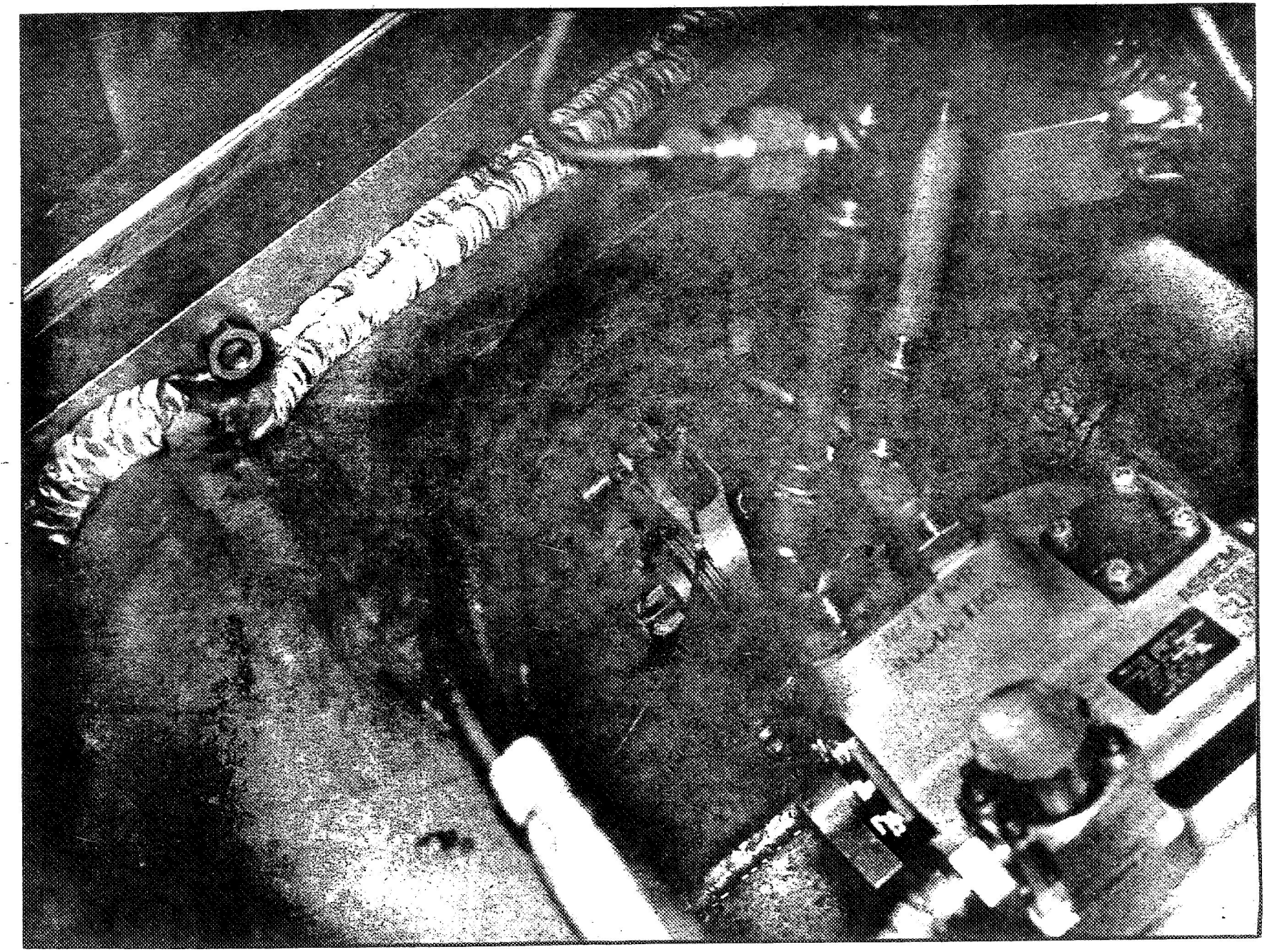


Figure 2-8. Accelerometer Locations, Tailstock End -- High-Temperature Vibration Test

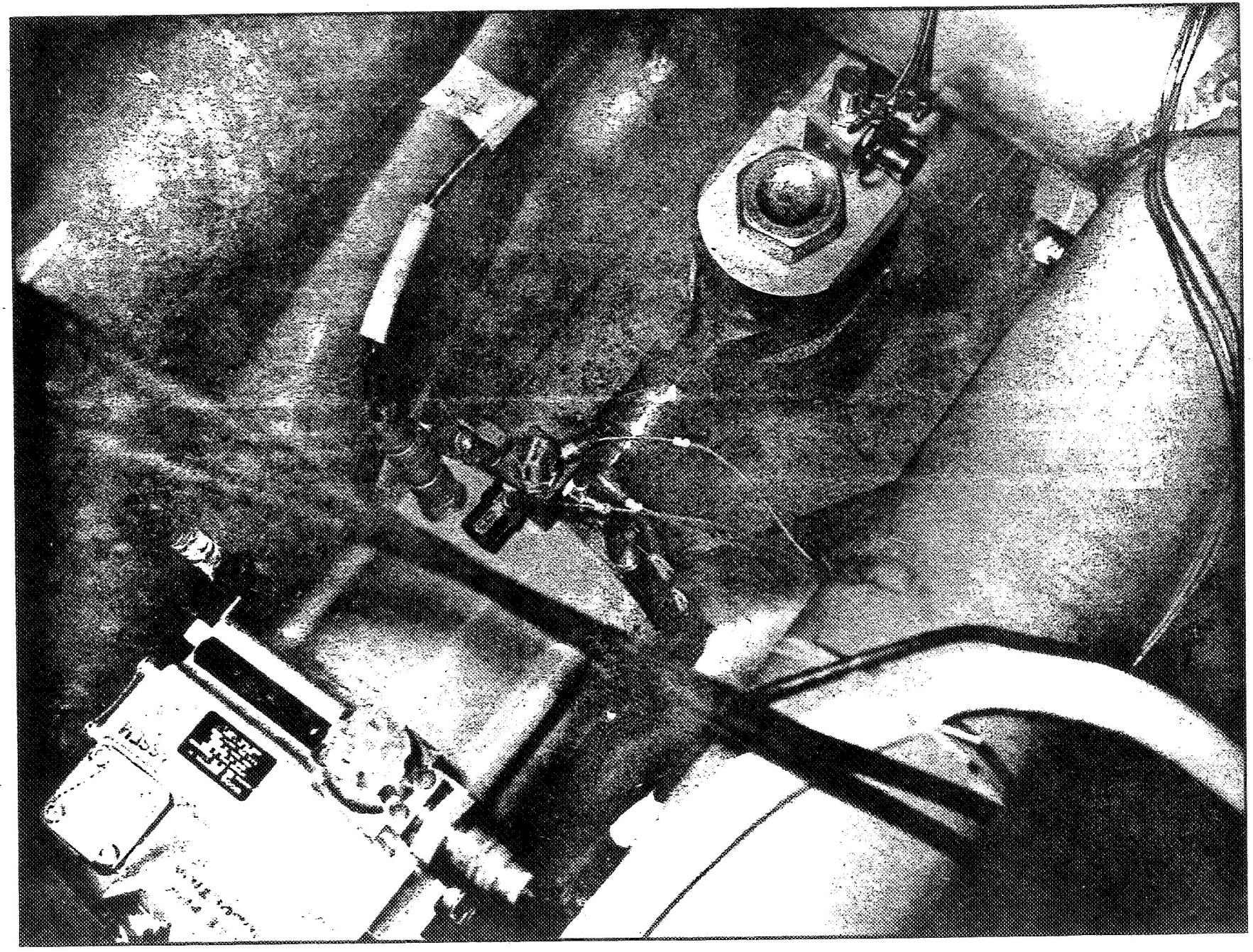


Figure 2-9. Accelerometer Locations, Rod End -- High-Temperature Vibration Test

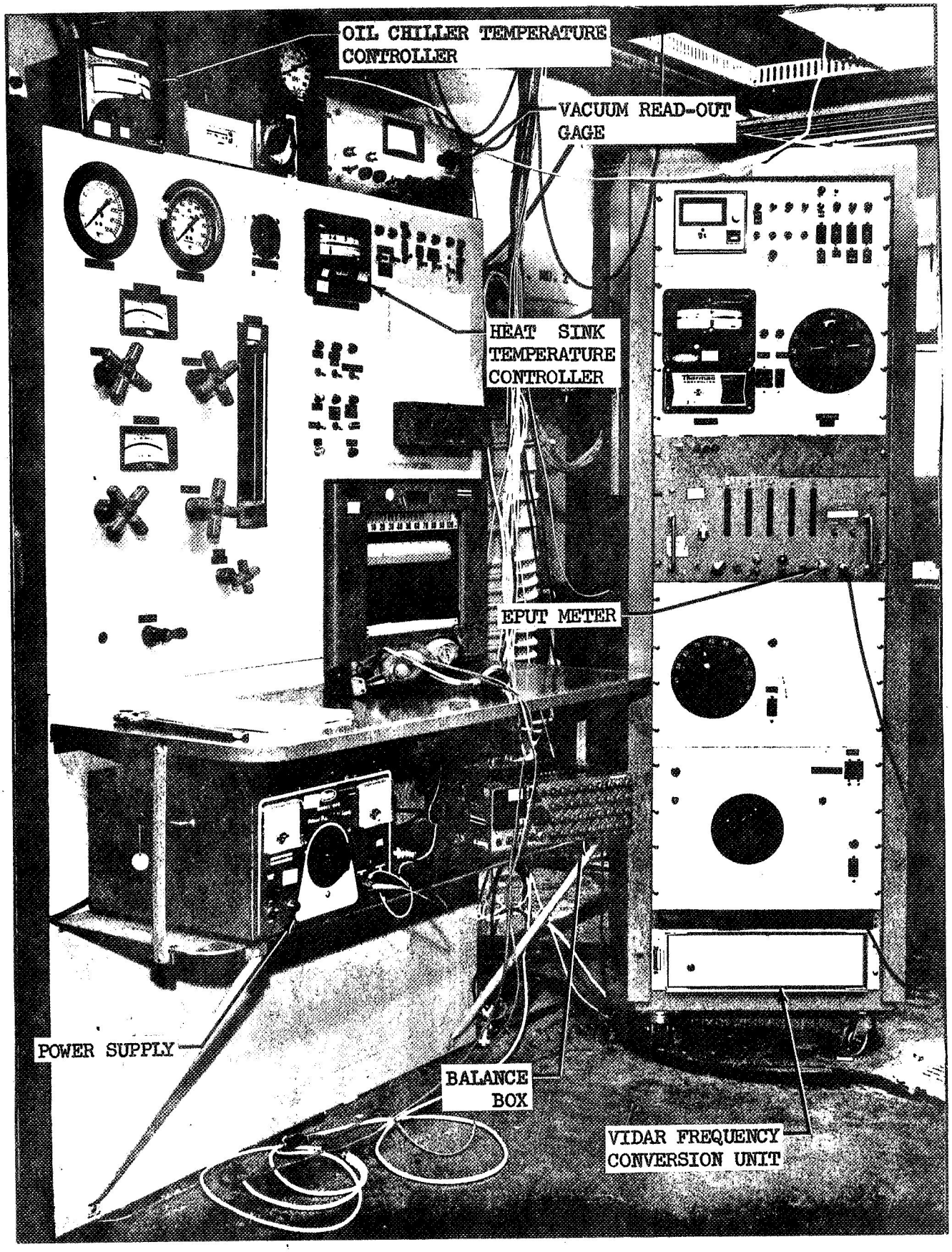


Figure 2-10. Thermal-Vacuum Test Control Panel

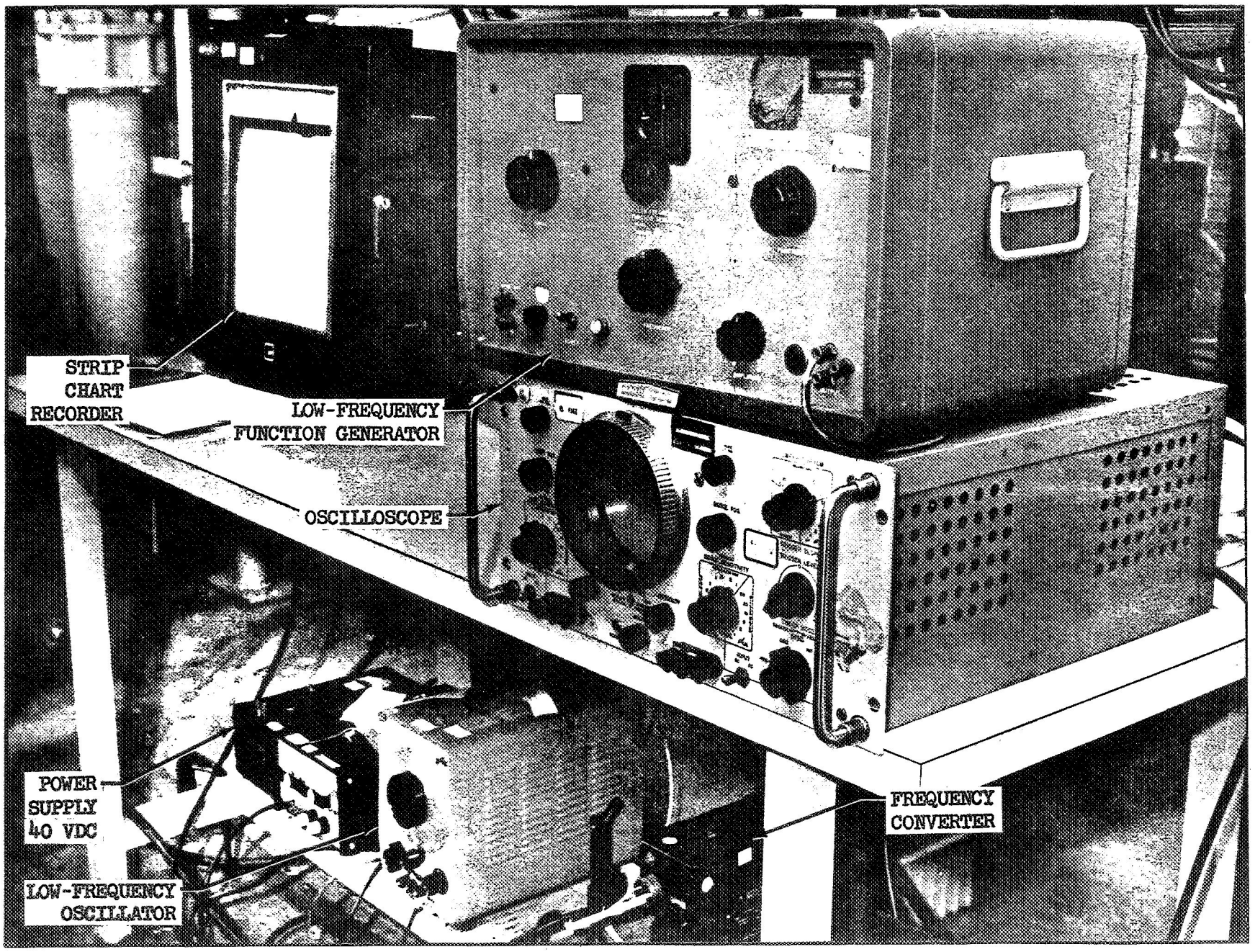


Figure 2-11. Instrumentation and Actuator Control Equipment

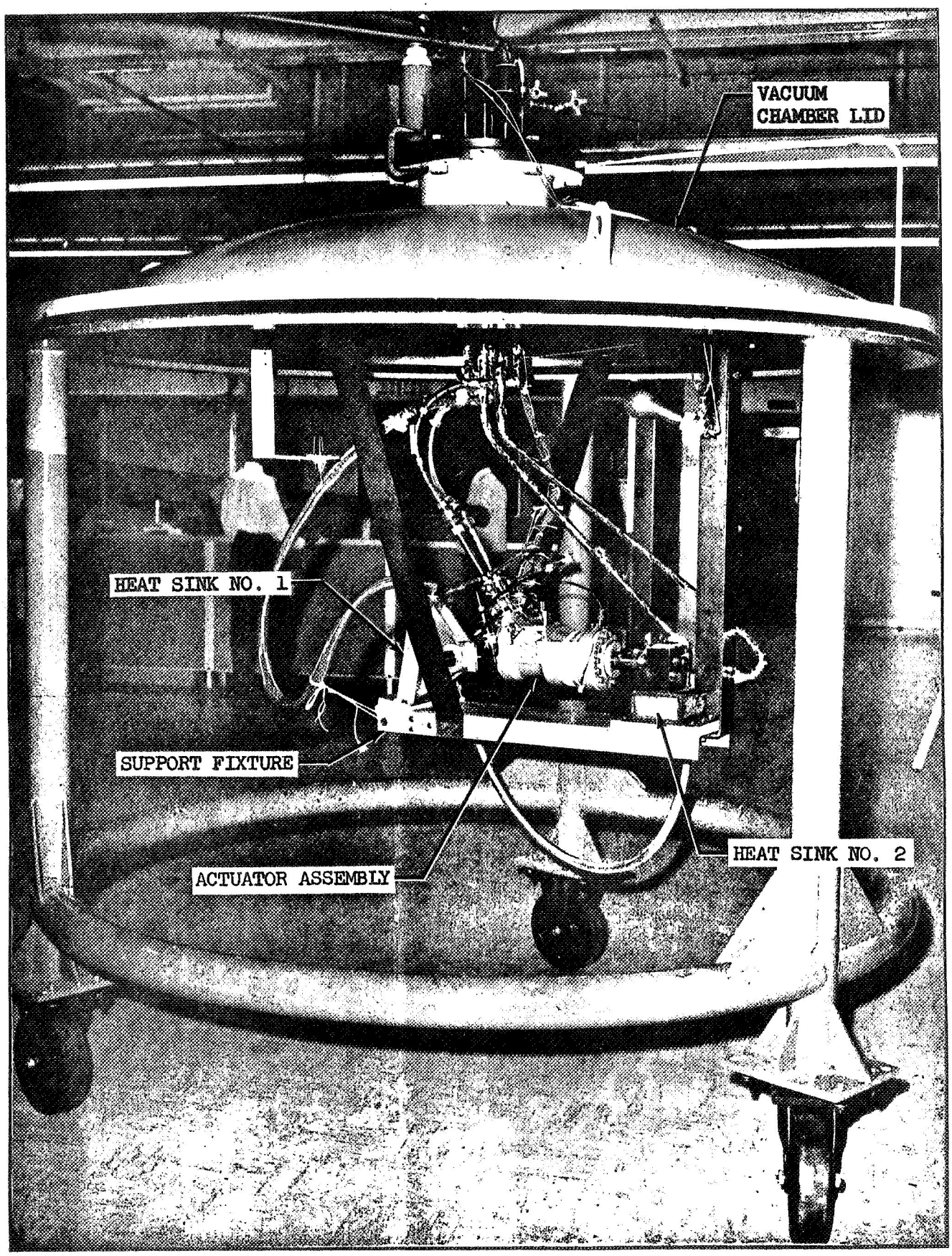


Figure 2-12. Vacuum Chamber Setup, Left Side

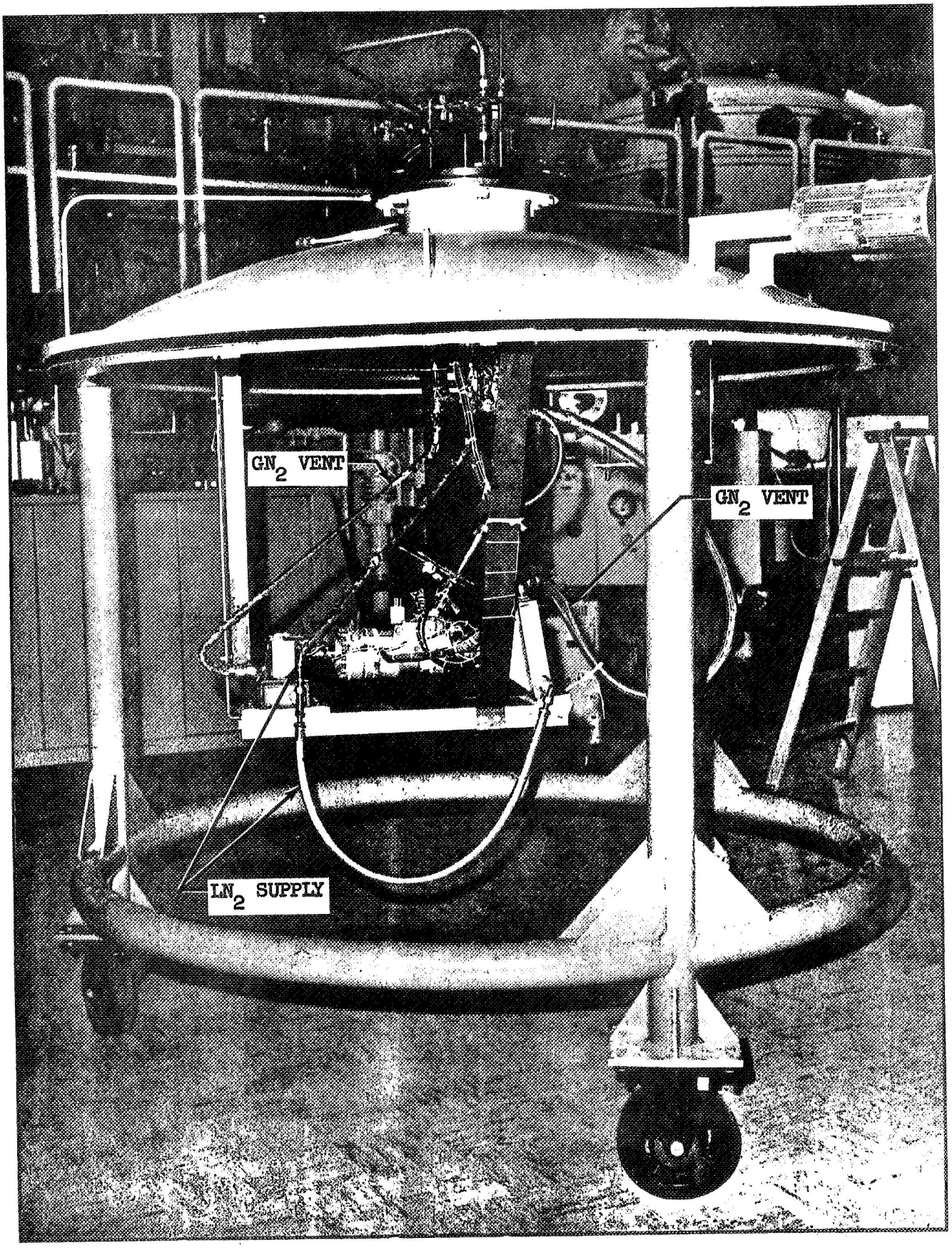


Figure 2-13. Vacuum Chamber Setup, Right Side

APPENDIX 3

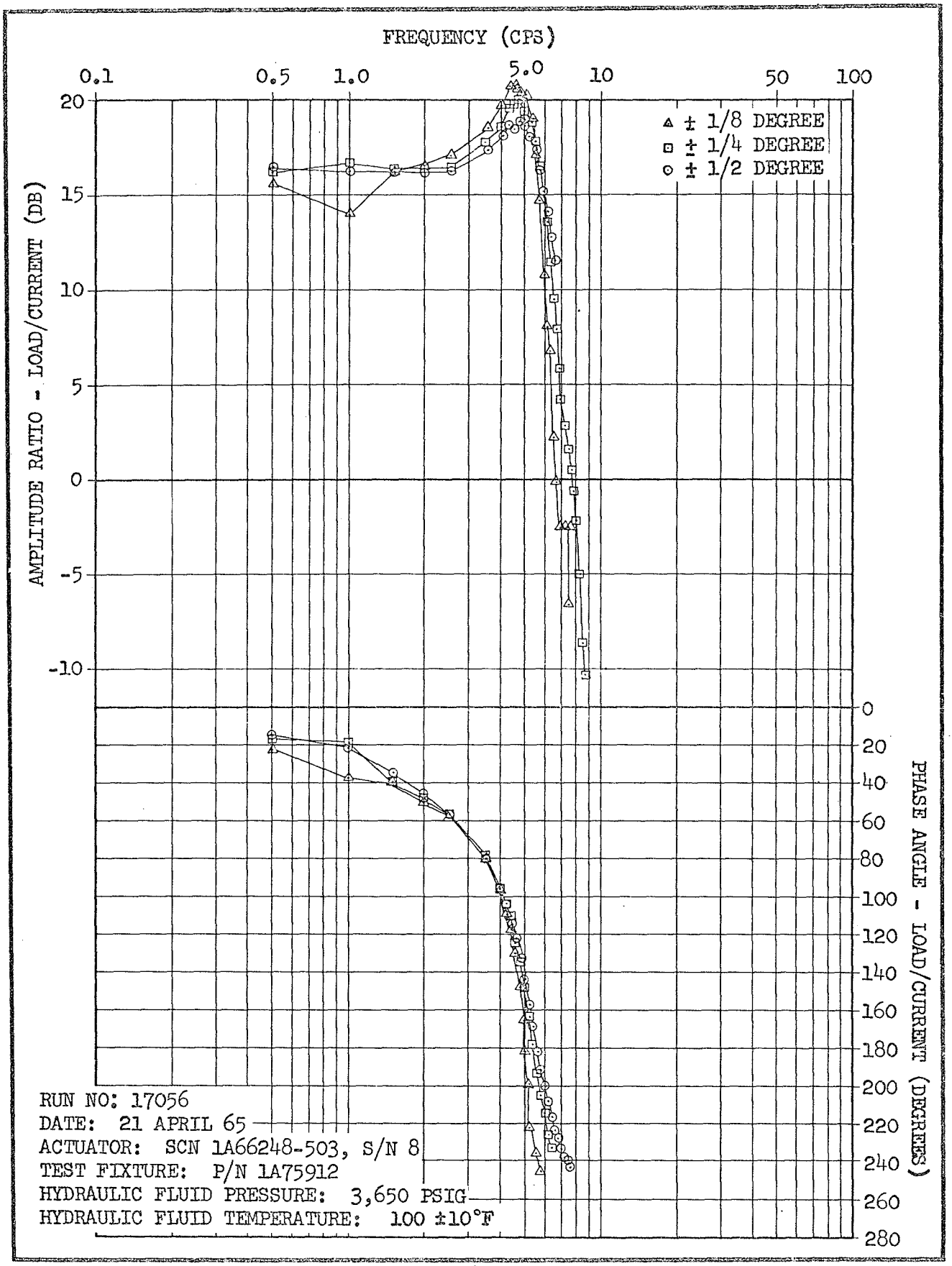


Chart 3-1. Acceptance Frequency Response, Load/Current - Test Specimen No. 2

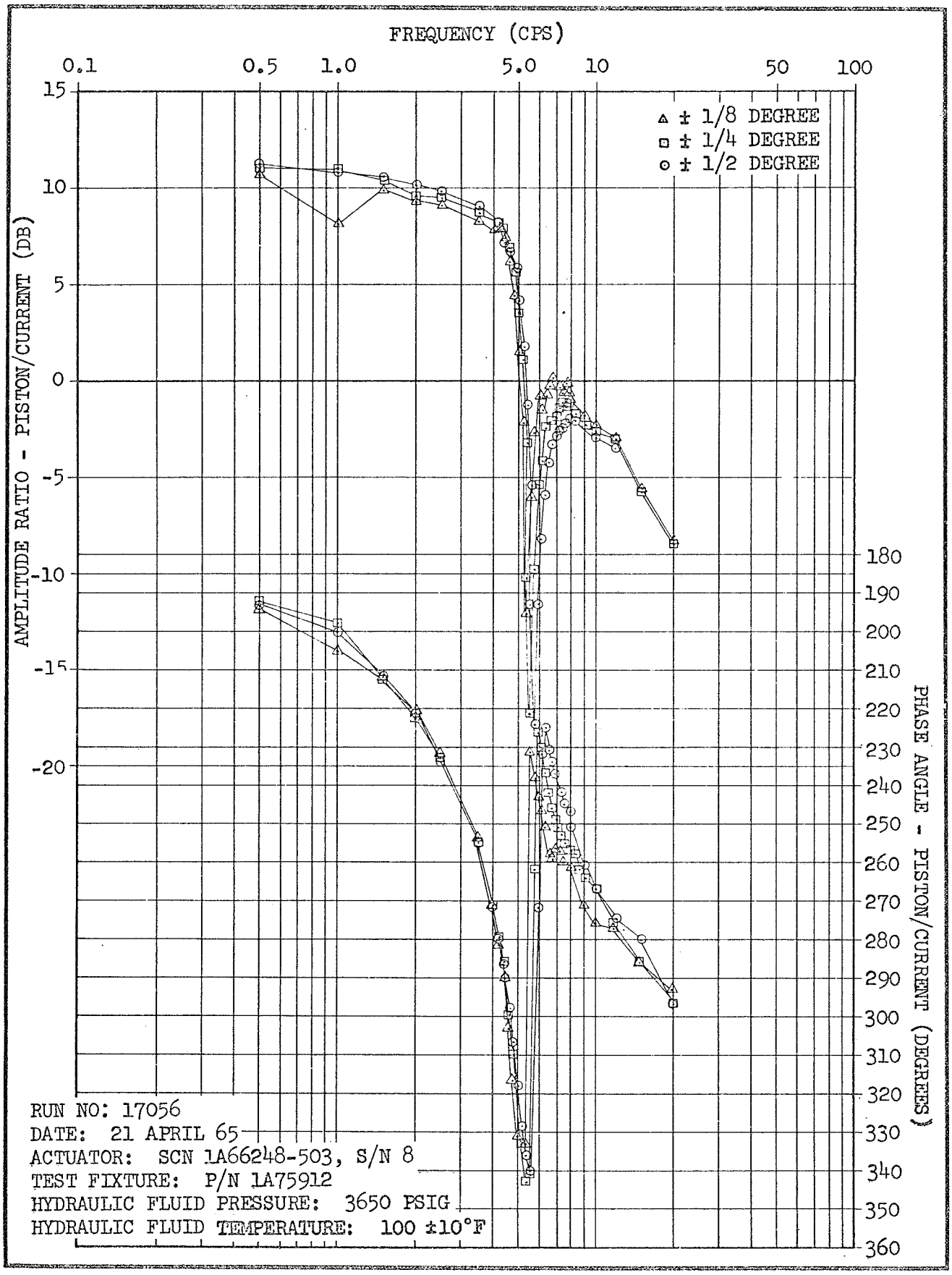


Chart 3-2. Acceptance Frequency Response, Piston/Current - Test Specimen No. 2

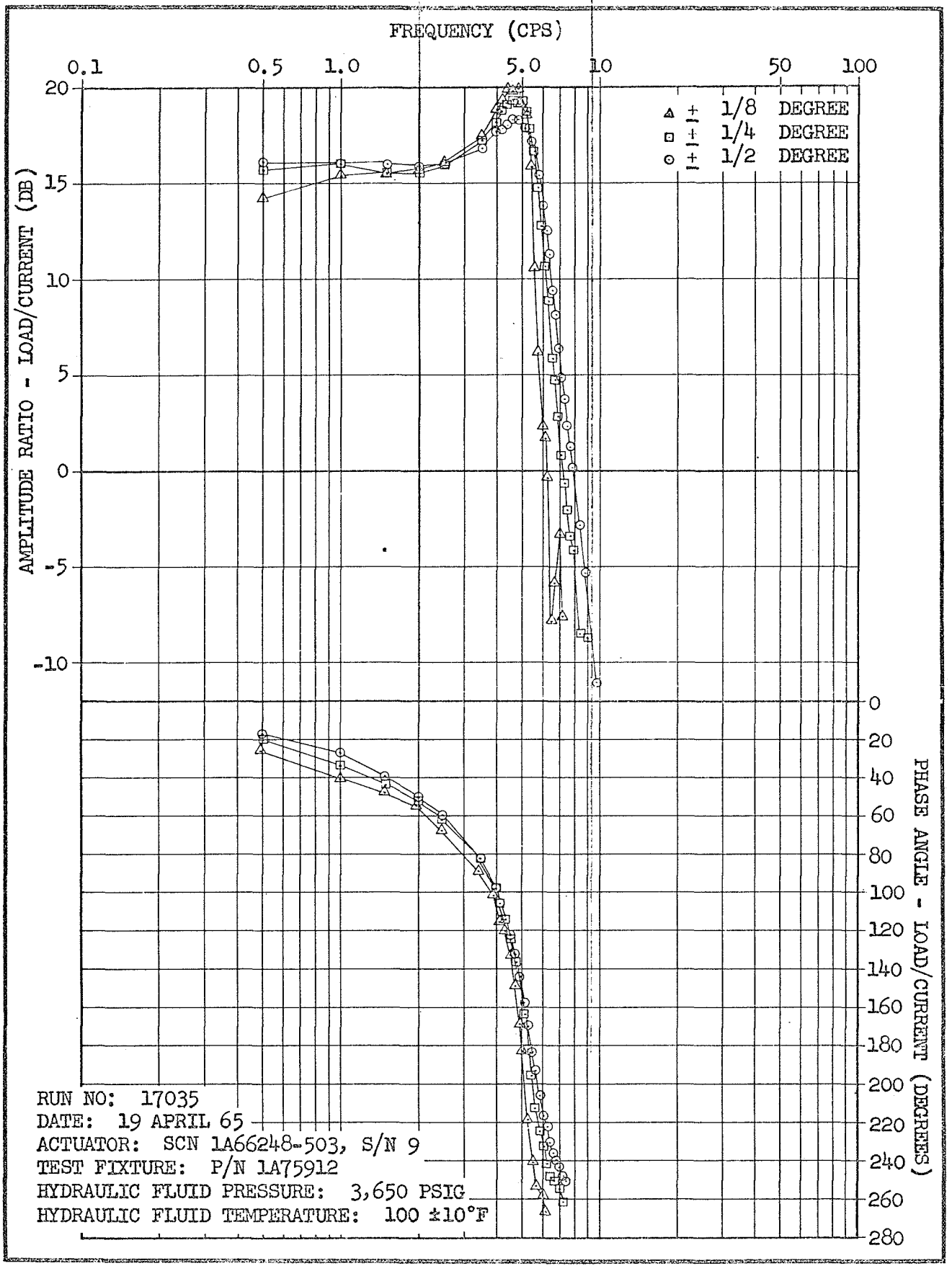


Chart 3-3. Acceptance Frequency Response, Load/Current - Test Specimen No. 3

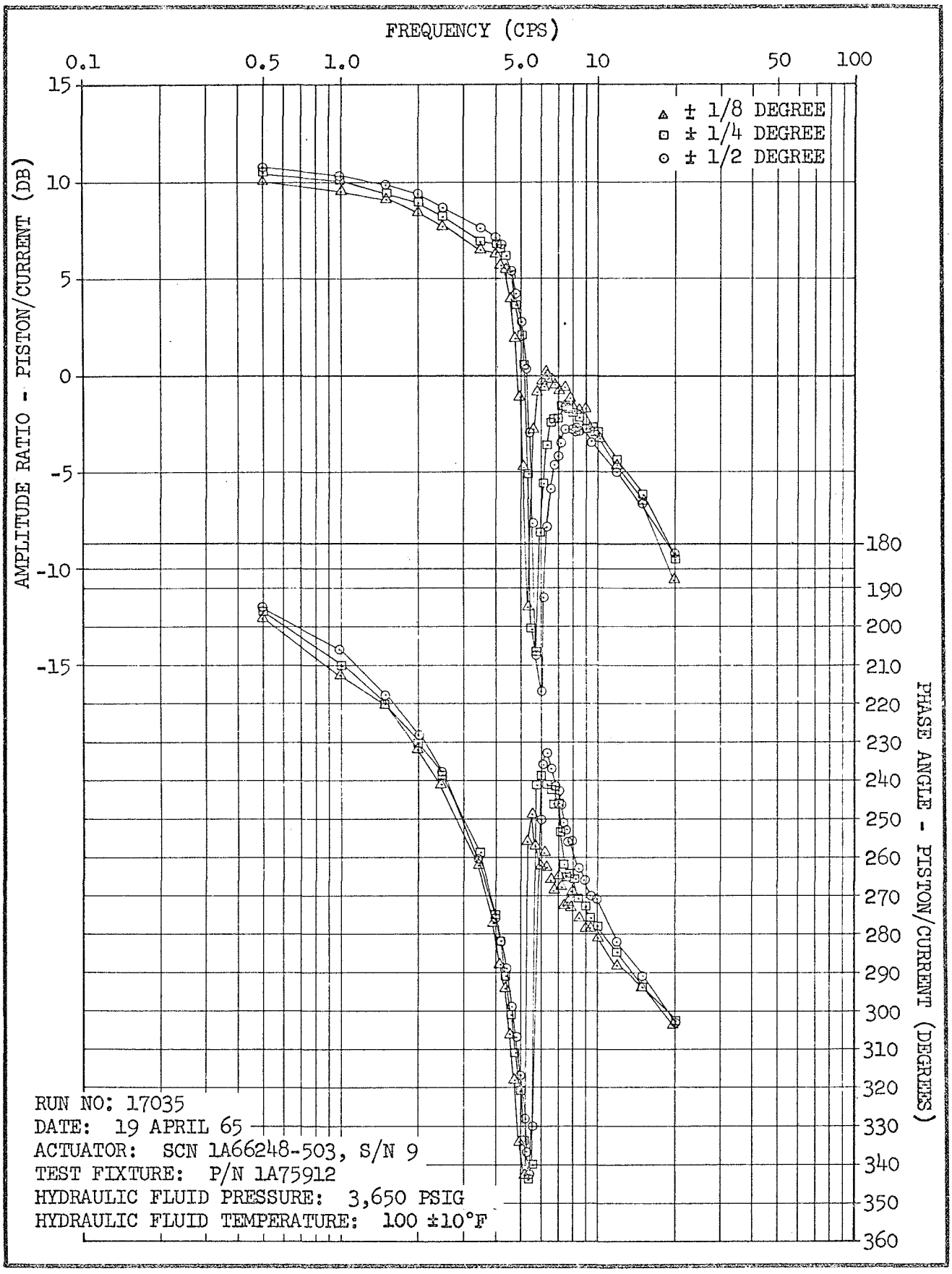


Chart 3-4. Acceptance Frequency Response, Piston/Current - Test Specimen No. 3

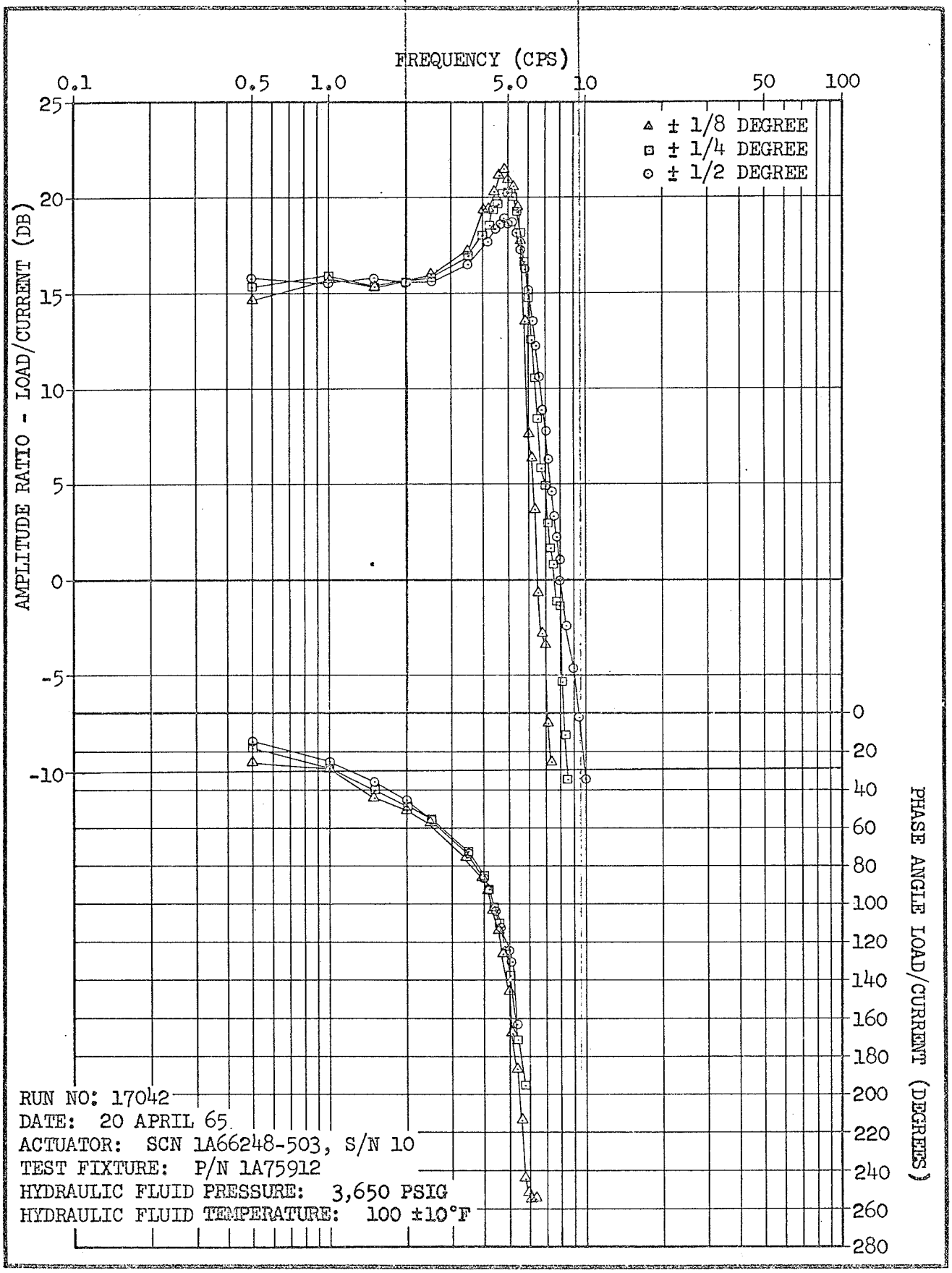


Chart 3-5. Acceptance Frequency Response, Load/Current - Test Specimen No. 4

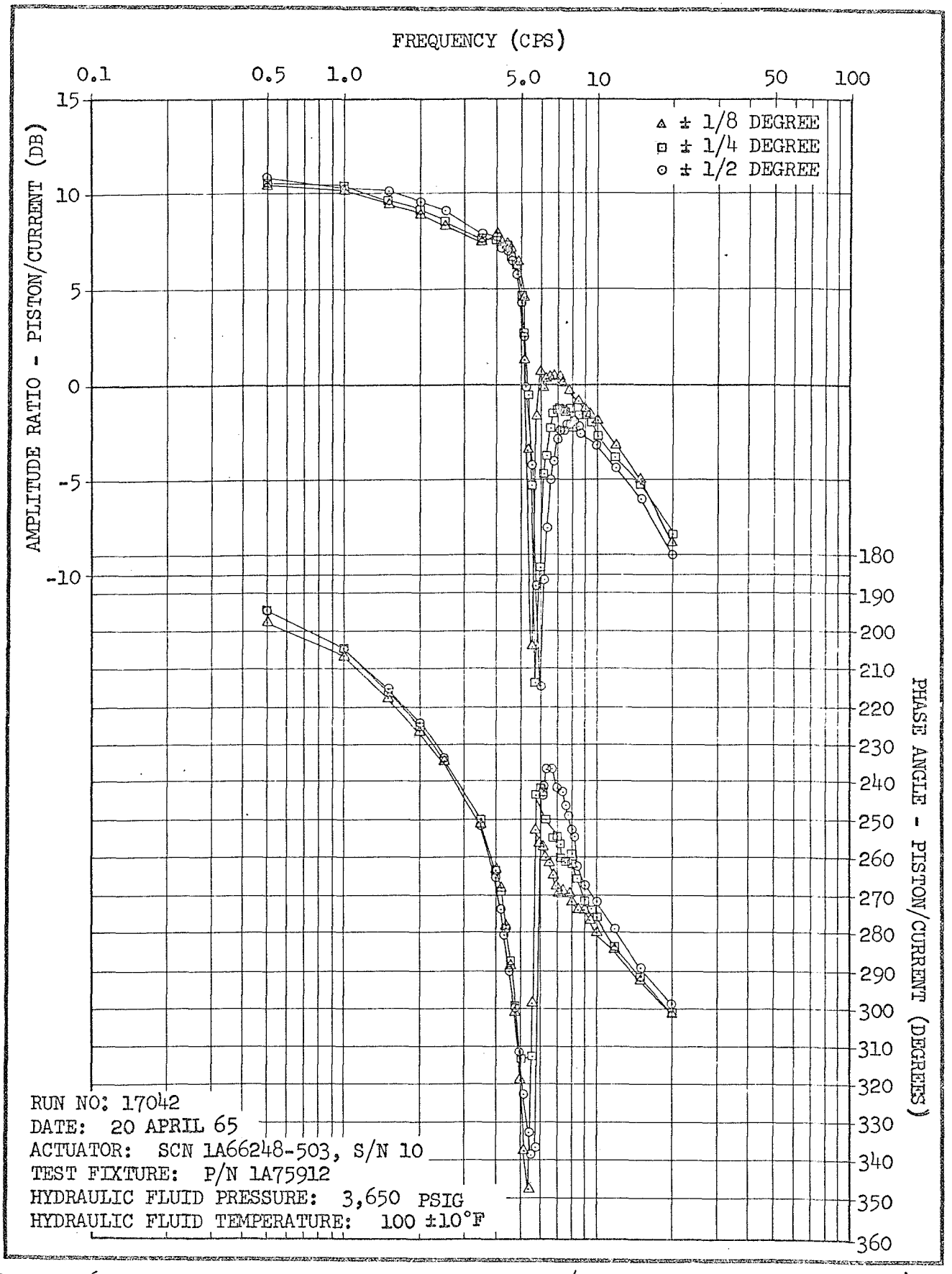


Chart 3-6. Acceptance Frequency Response, Piston/Current - Test Specimen No. 4

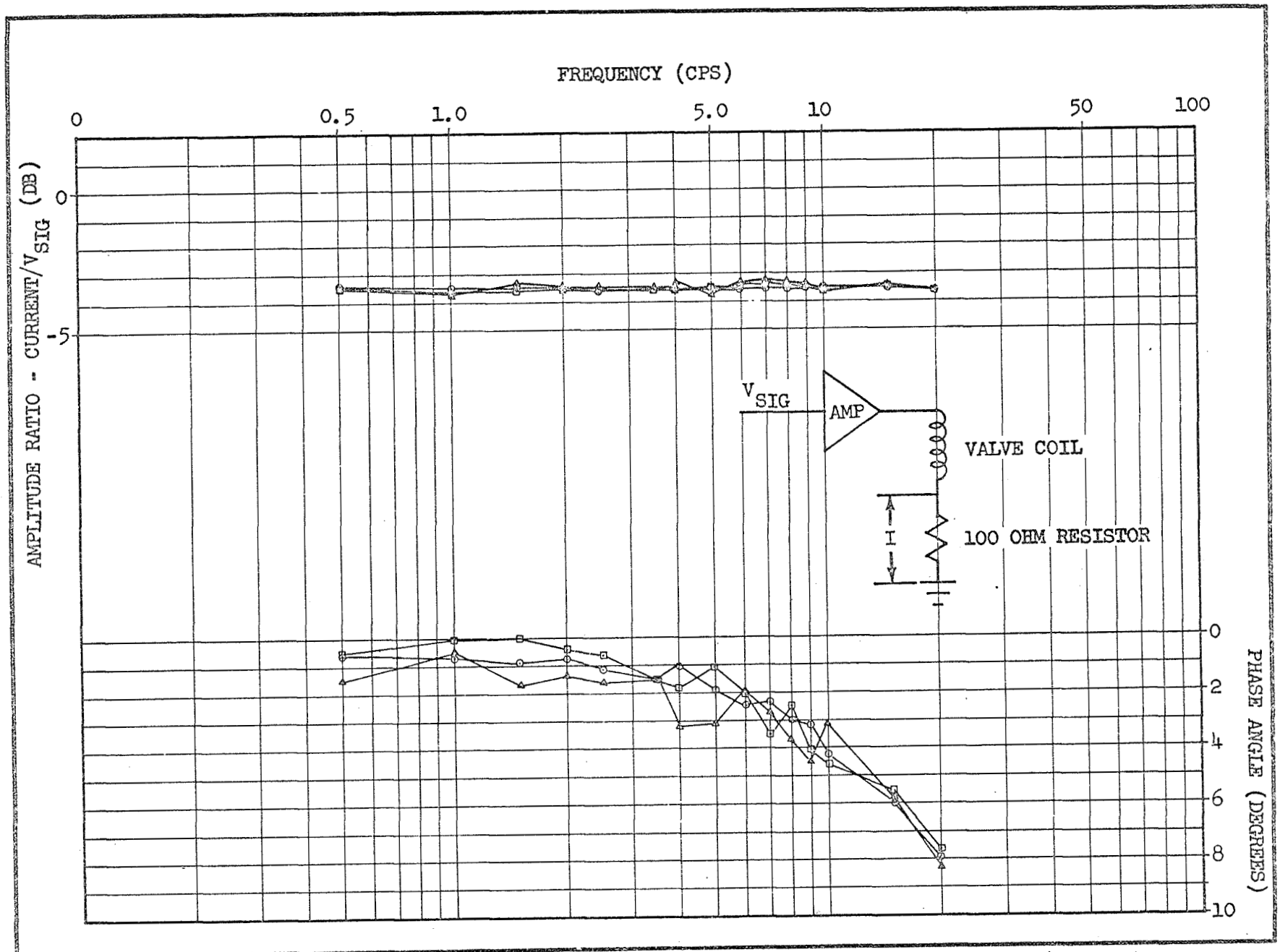


Chart 3-7. Temperature Environmental Frequency Response of Douglas Amplifier, P/N 1A93140

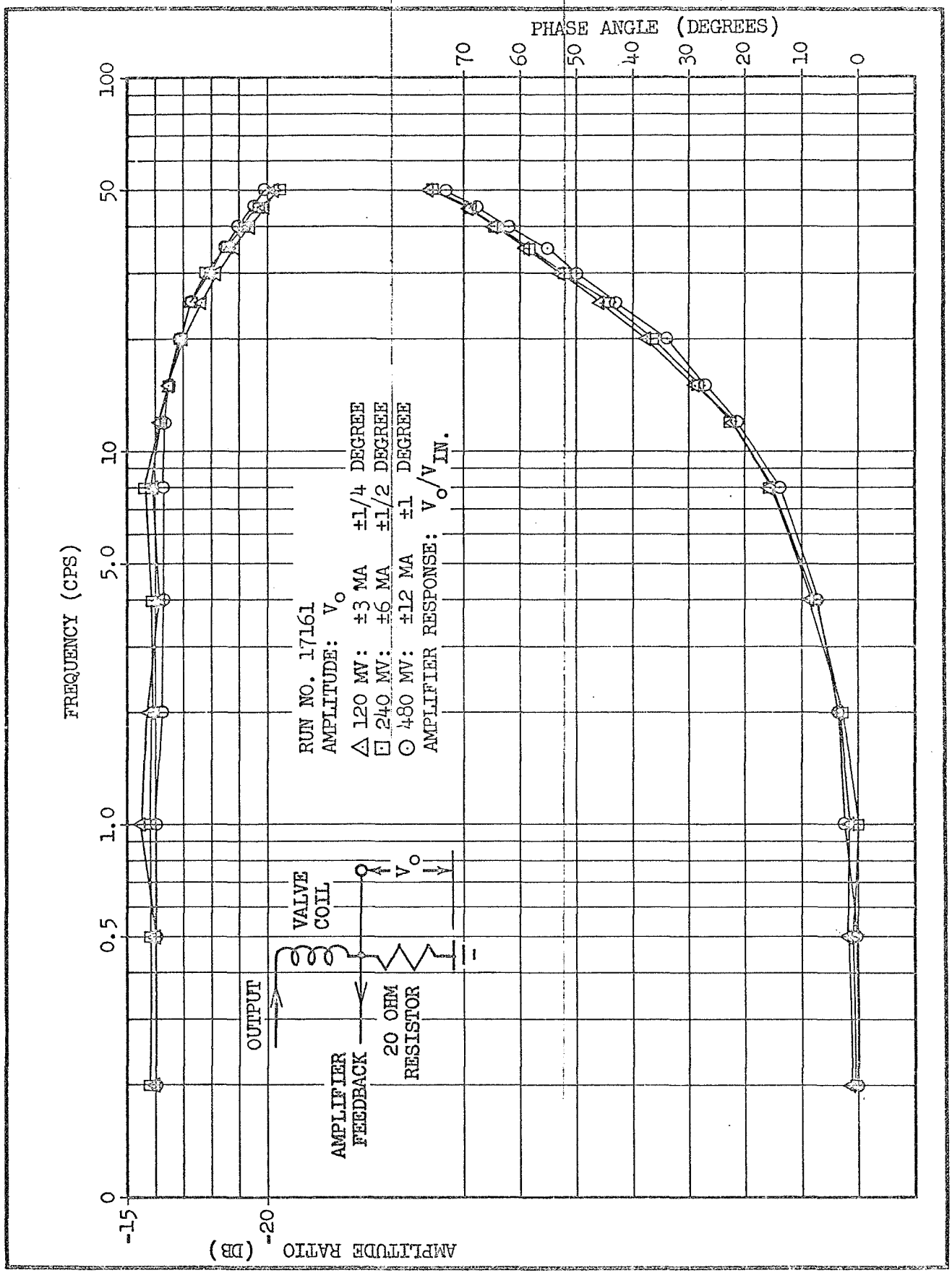


Chart 3-8. Temperature Environmental Frequency Response of NASA Amplifier, P/N 50M37393

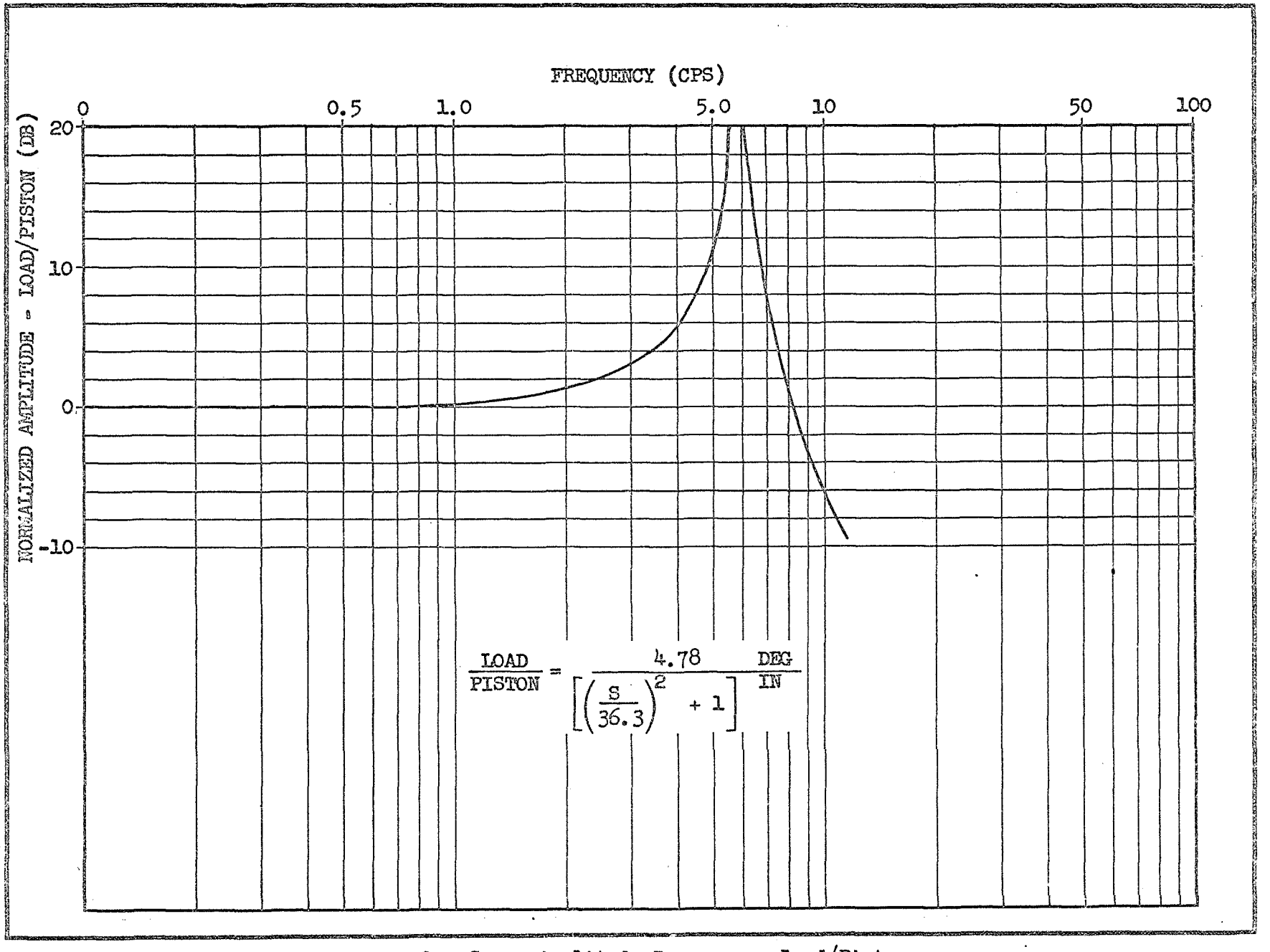


Chart 3-9. Servo Amplitude Response, Load/Piston

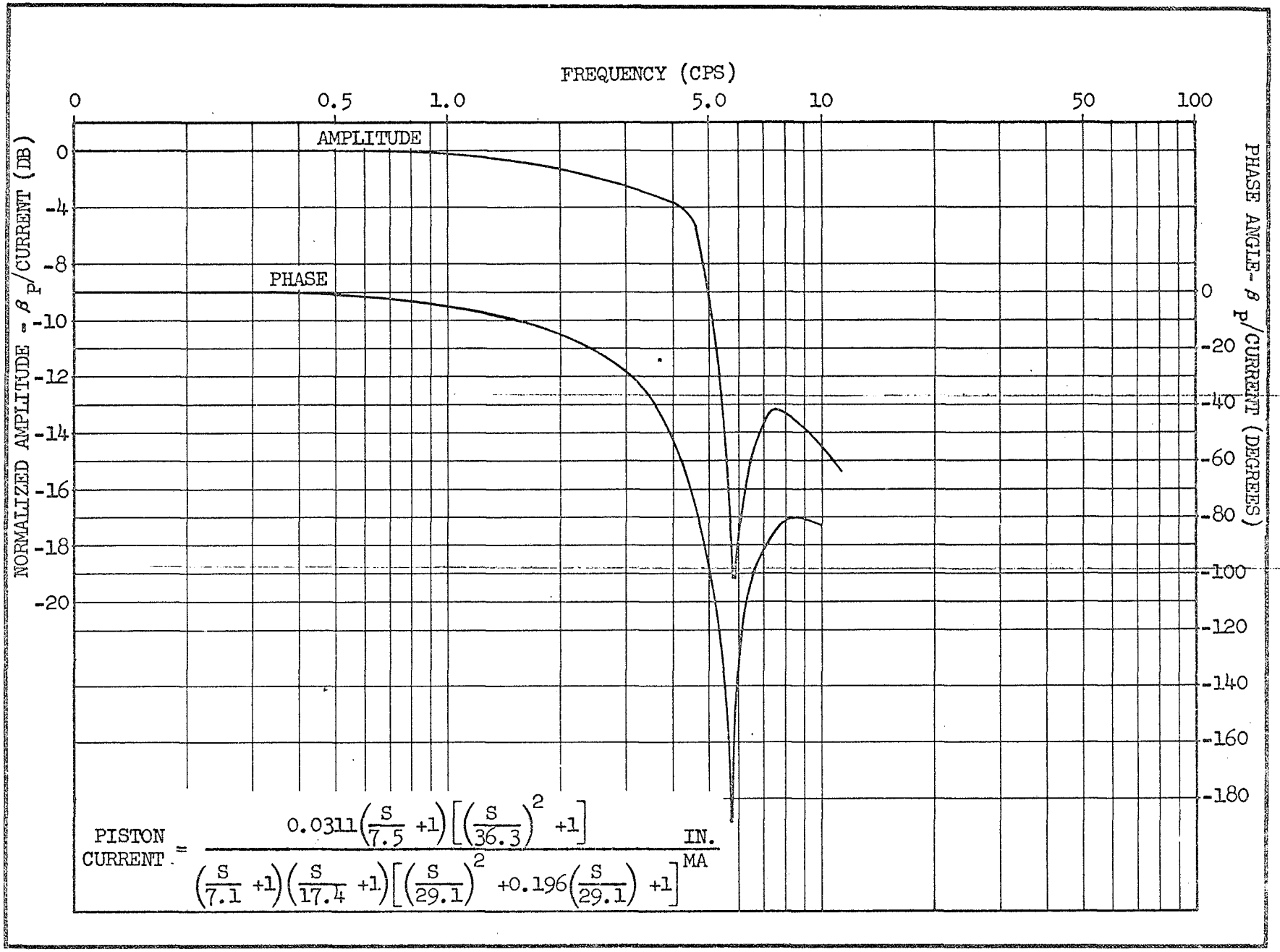


Chart 3-10. Servo Amplitude and Phase Response, Piston/Current

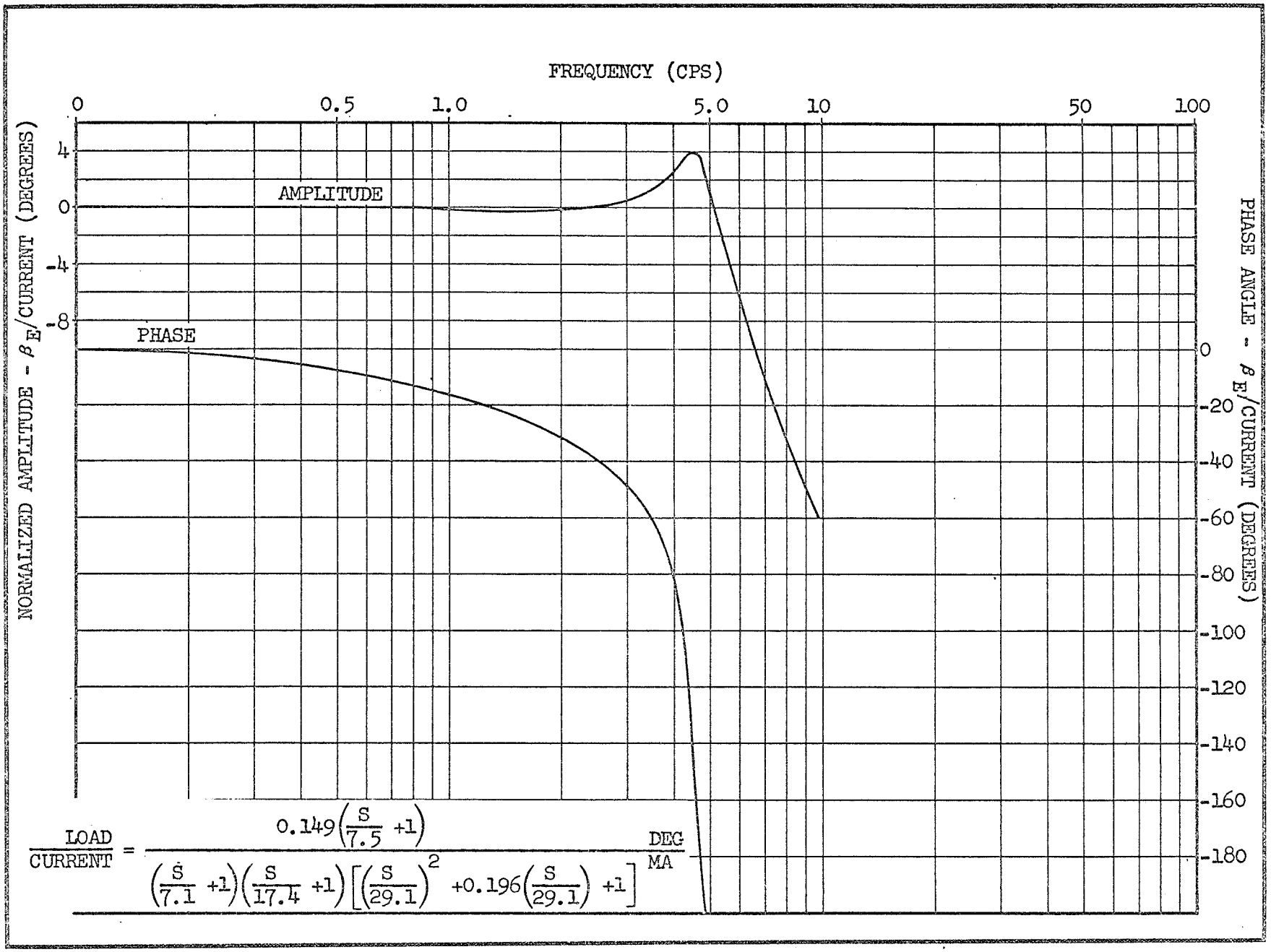


Chart 3-11. Servo Amplitude and Phase Response, Load/Current

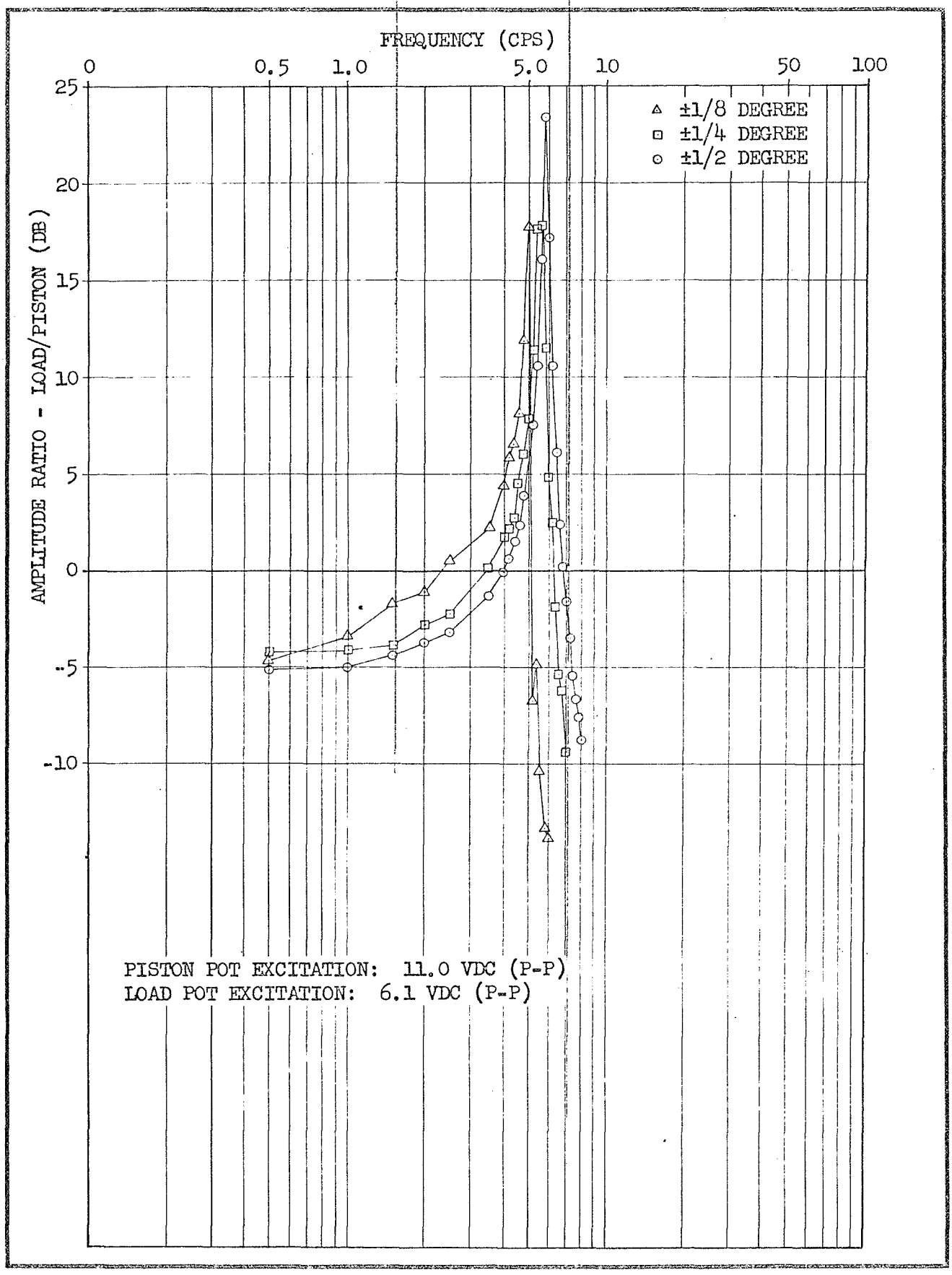


Chart 3-12. Amplitude Response of Spring-Mass Load Simulator

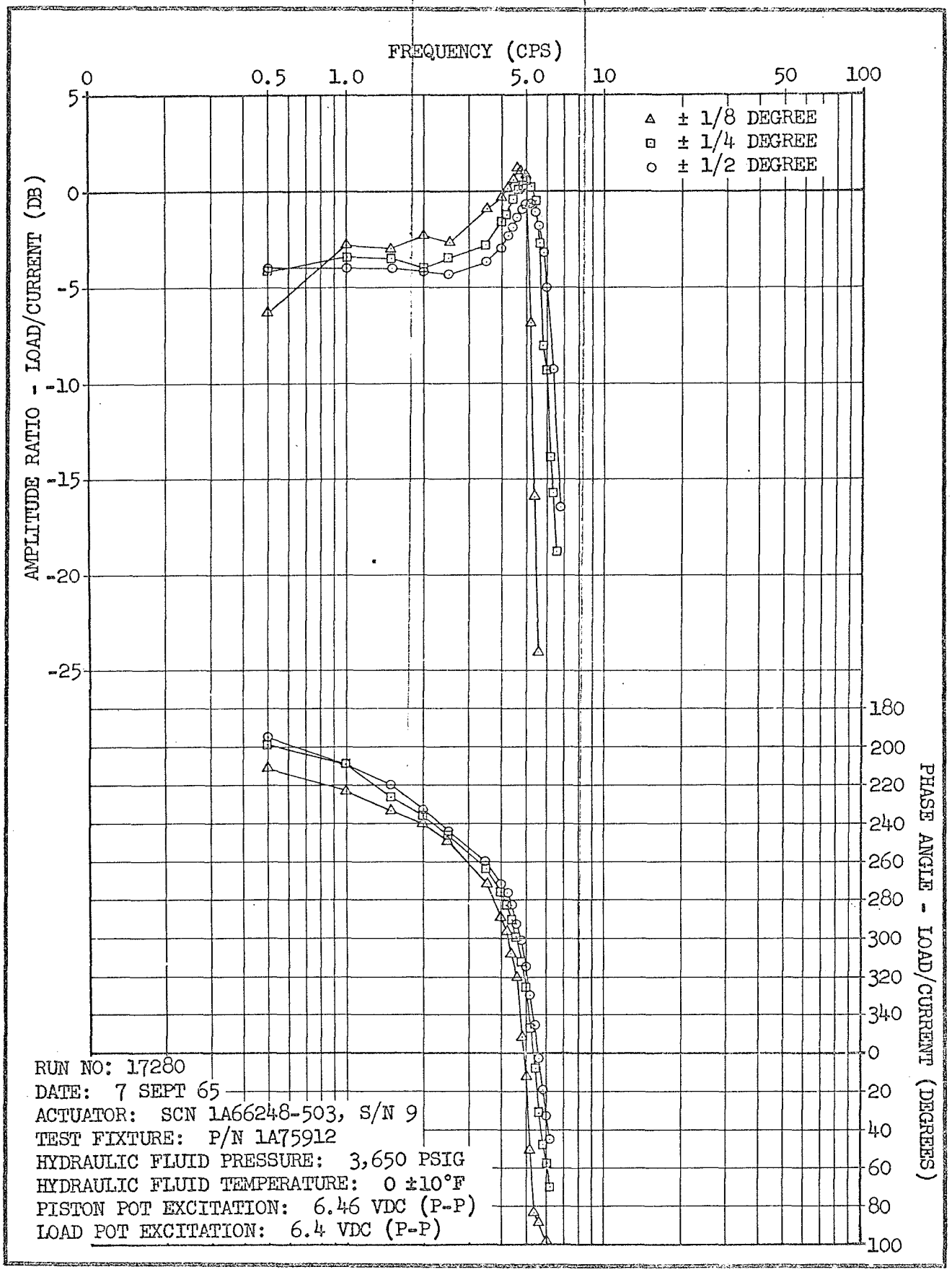


Chart 3-13. Temperature Environmental Frequency Response at 0°F, Load/Current - Test Specimen No. 3

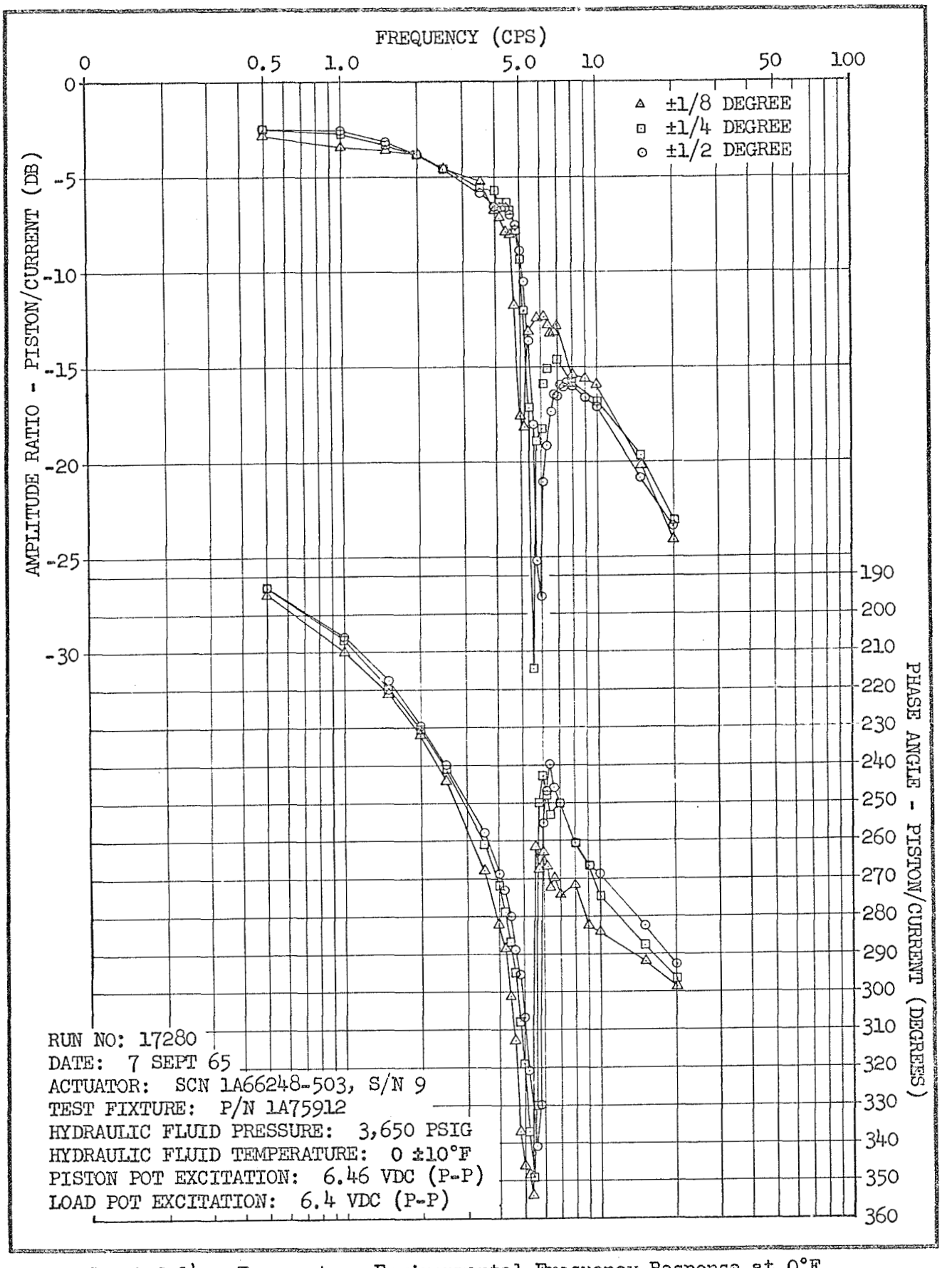


Chart 3-14. Temperature Environmental Frequency Response at 0°F, Piston/Current - Test Specimen No. 3

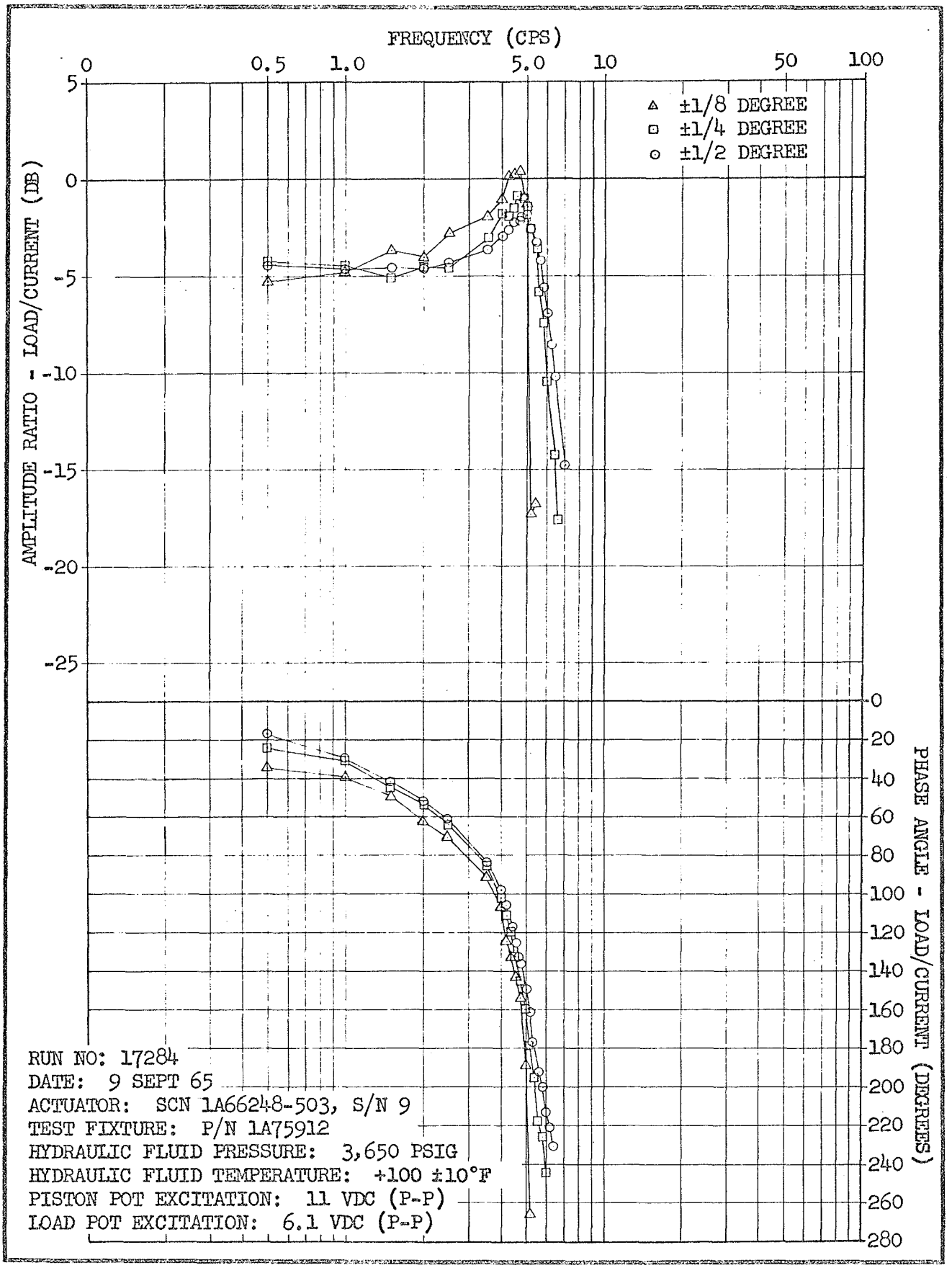


Chart 3-15. Post-environmental Frequency Response at Room Temperature, Load/Current - Test Specimen No. 3

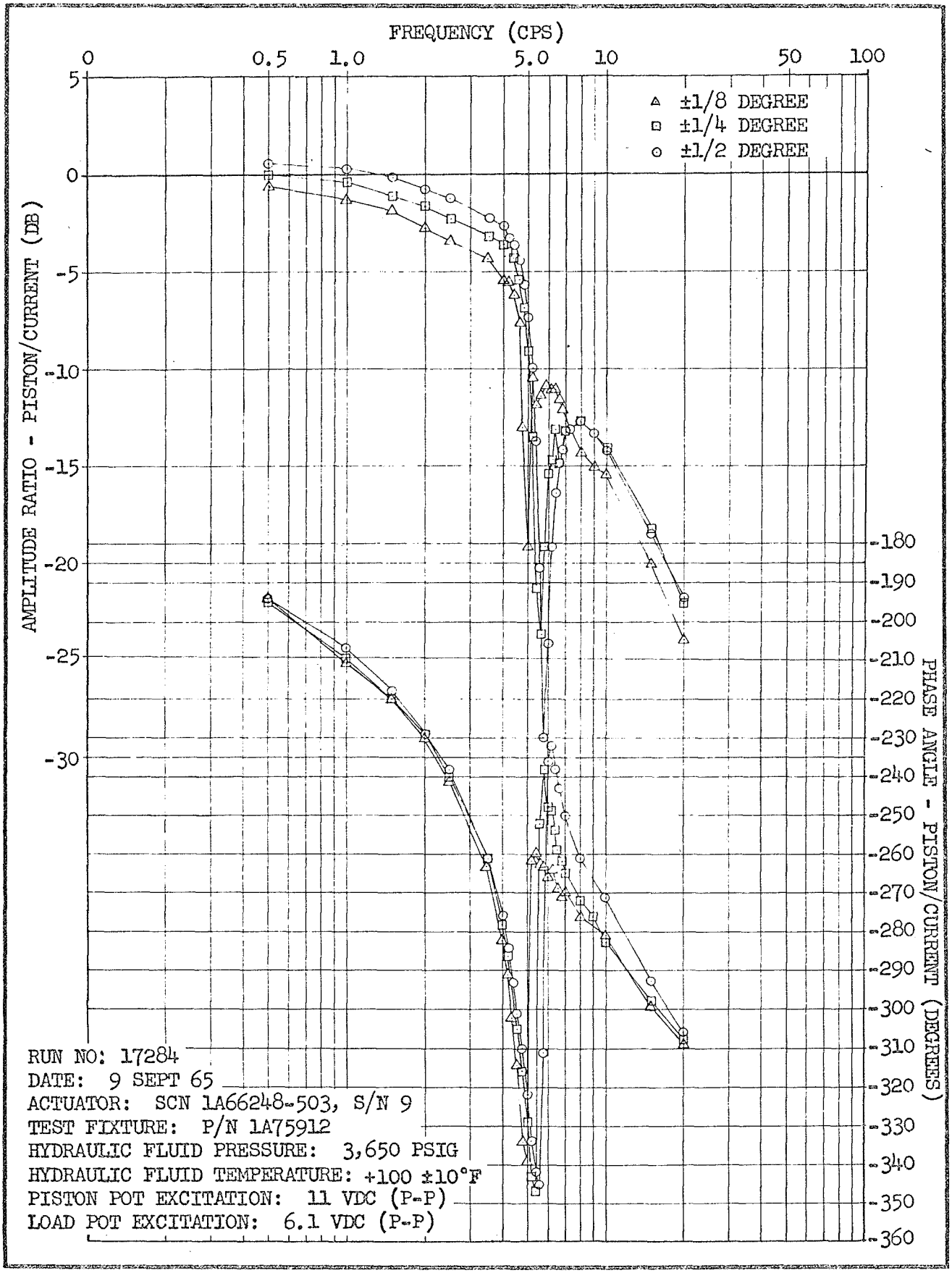


Chart 3-16. Post-environmental Frequency Response at Room Temperature, Piston/Current - Test Specimen No. 3

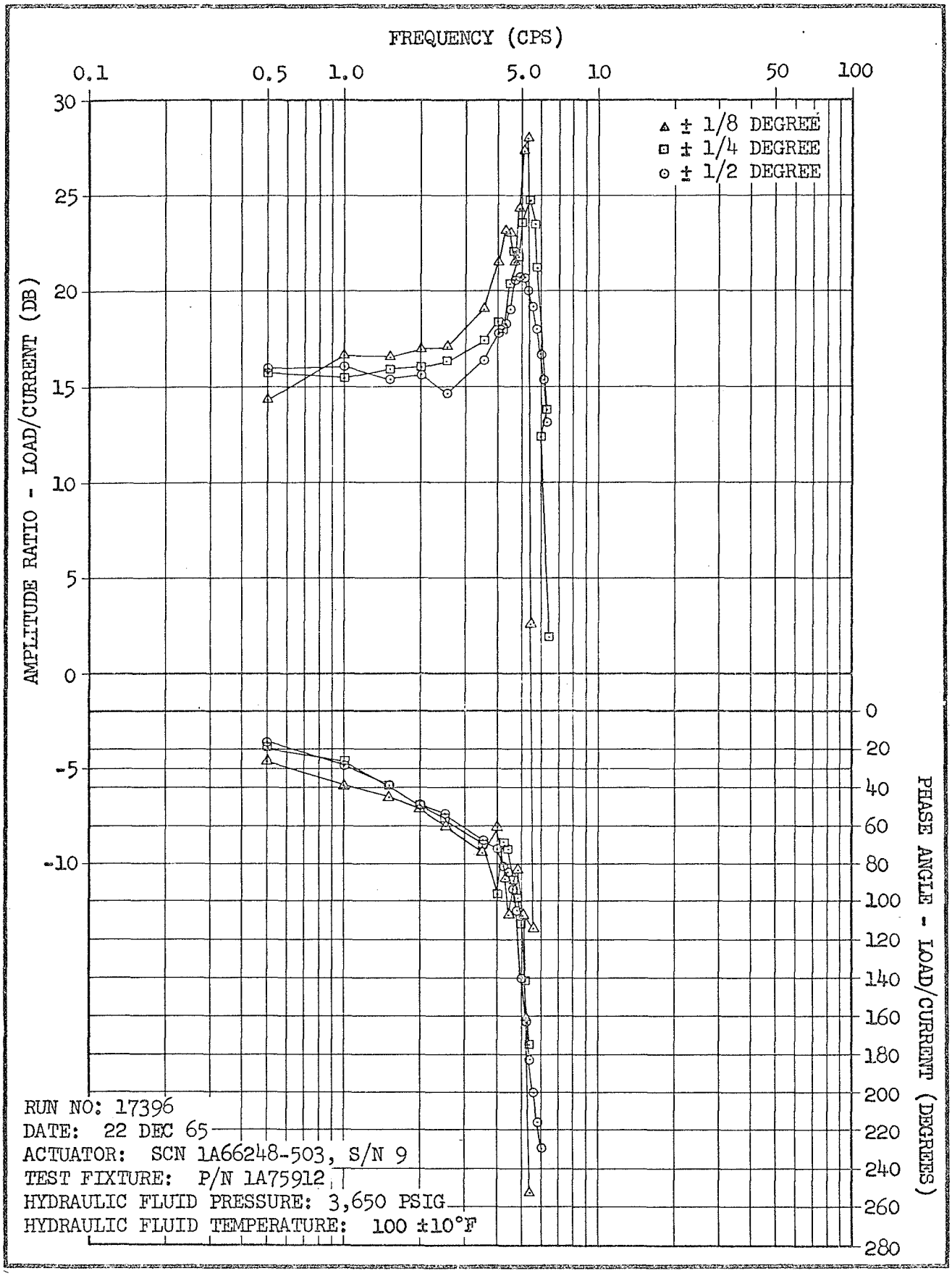


Chart 3-17. Post-High-Temperature Vibration Frequency Response, Load/Current - Test Specimen No. 3

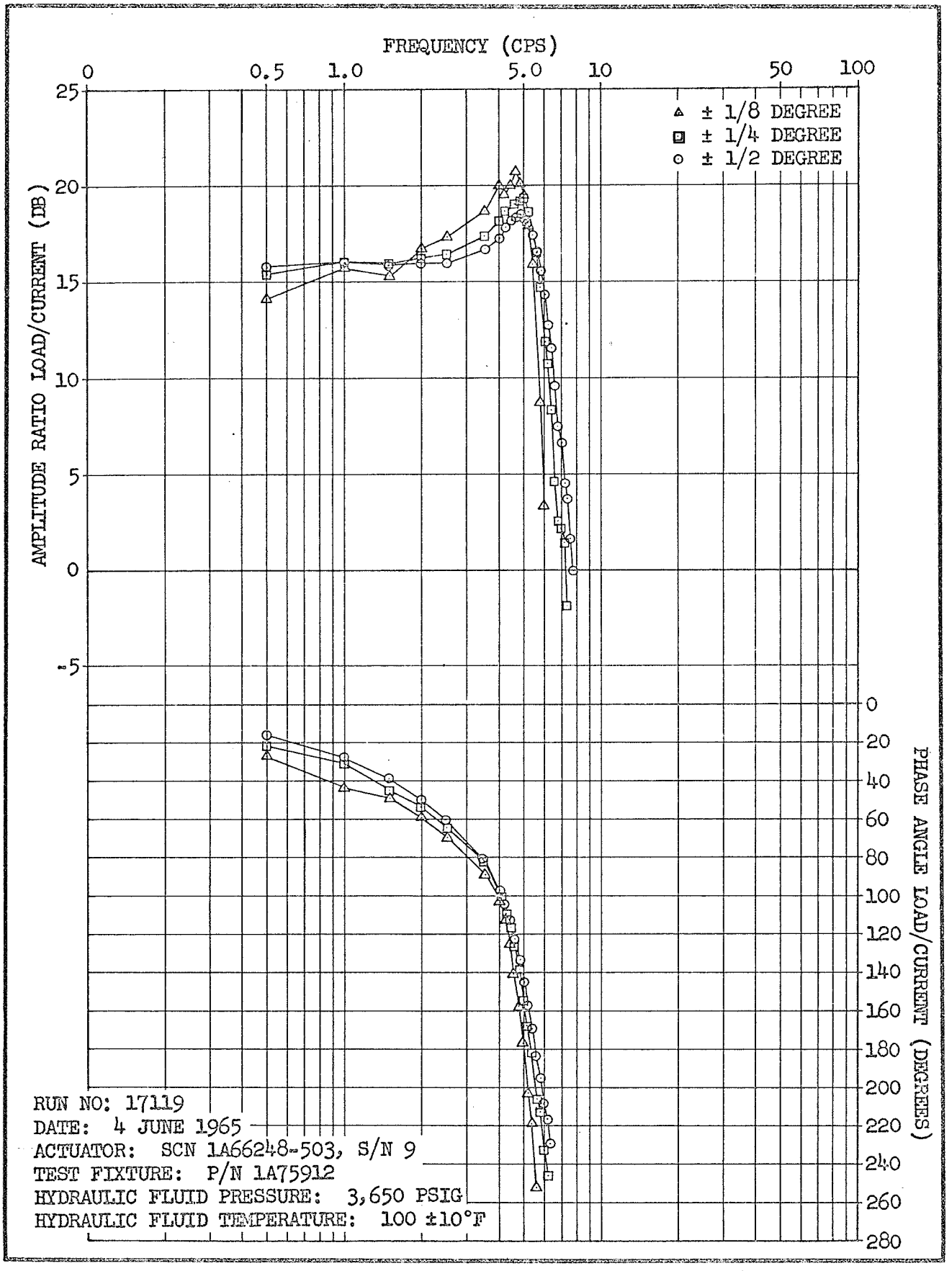


Chart 3-18. Post-Acceleration Frequency Response, Load/Current - Test Specimen No. 3

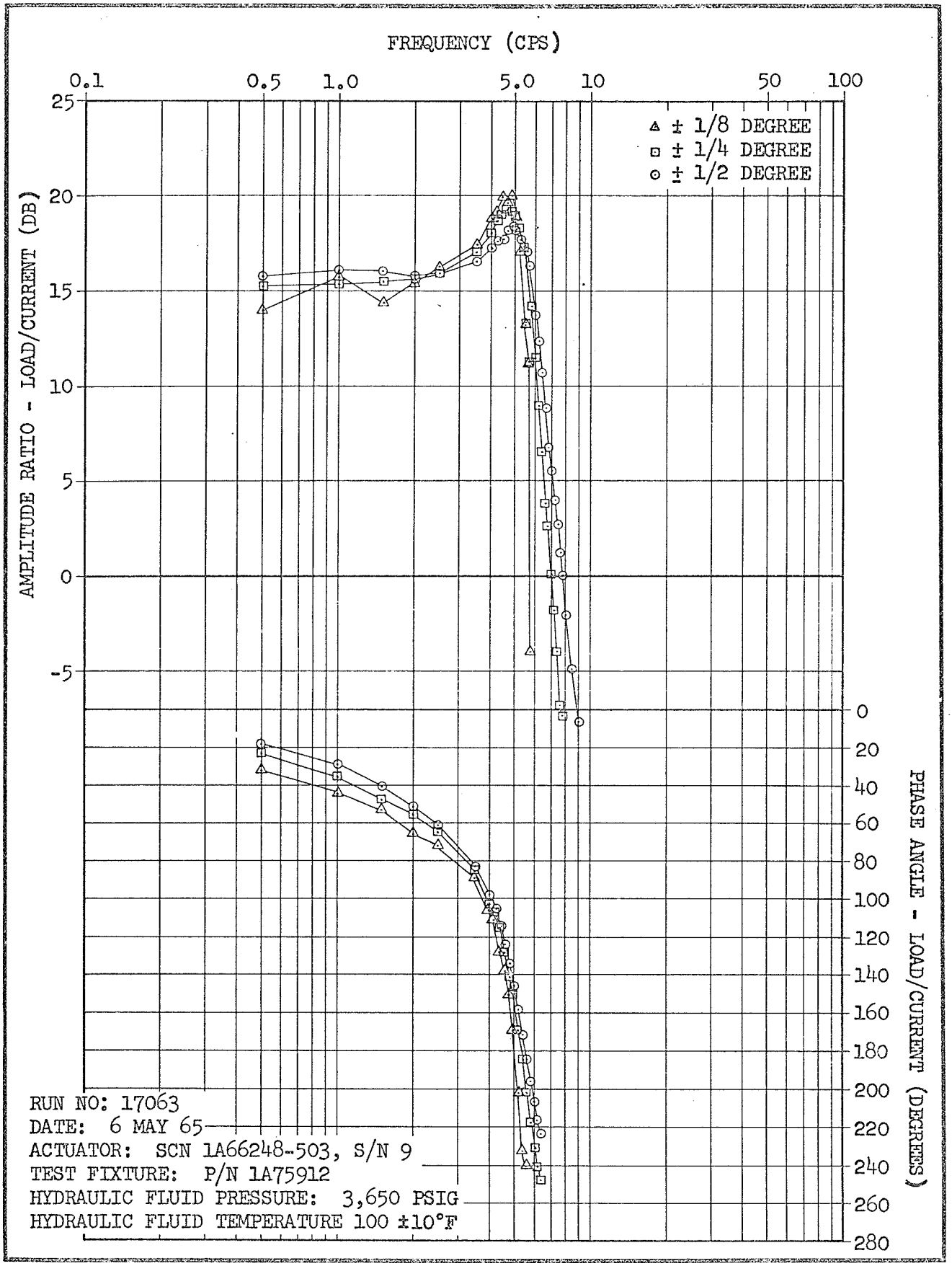


Chart 3-19. Post-Mechanical Shock Frequency Response, Load/Current - Test Specimen No. 3

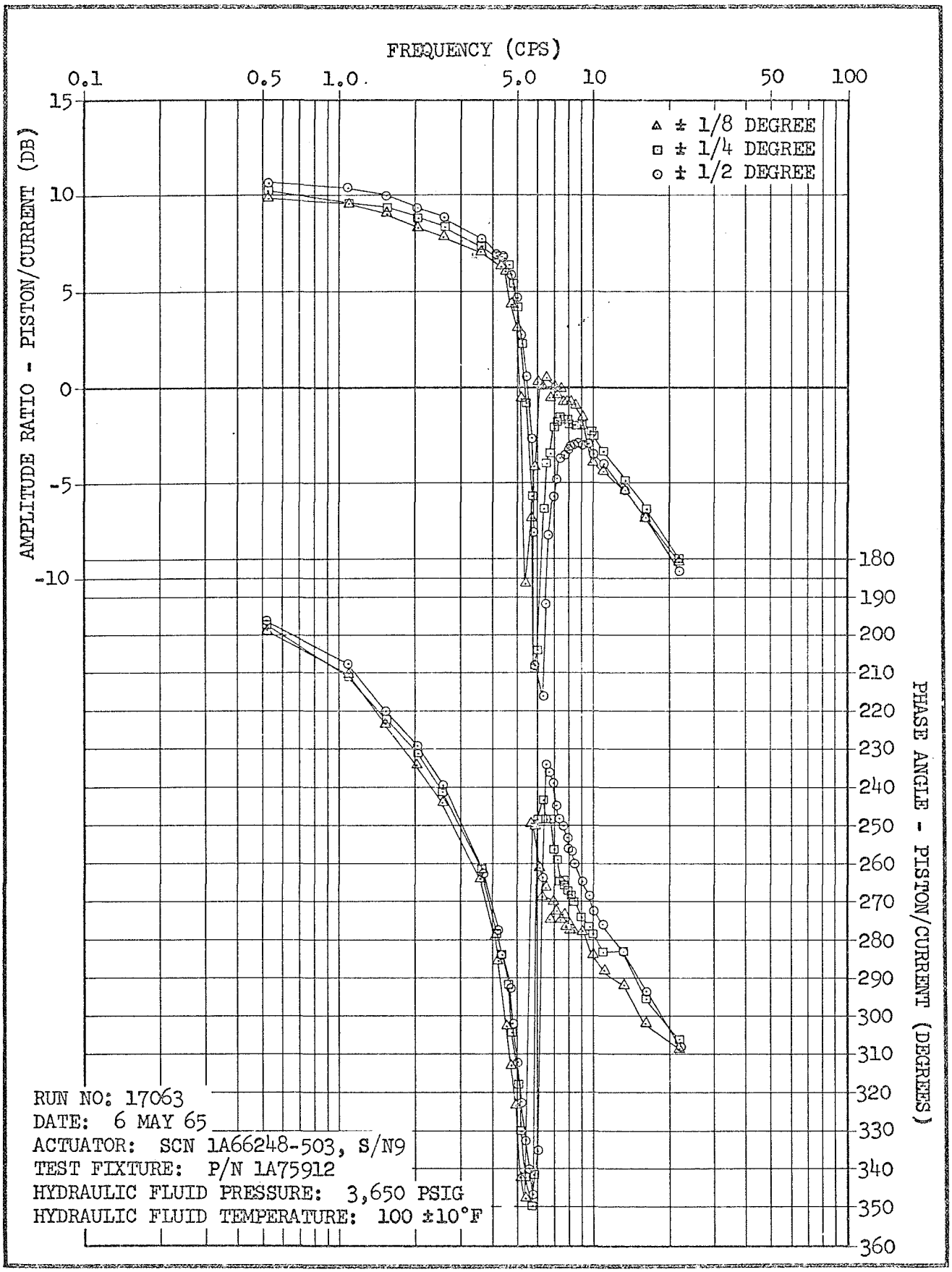


Chart 3-20. Post-Mechanical Shock Frequency Response, Piston/Current - Test Specimen No. 3

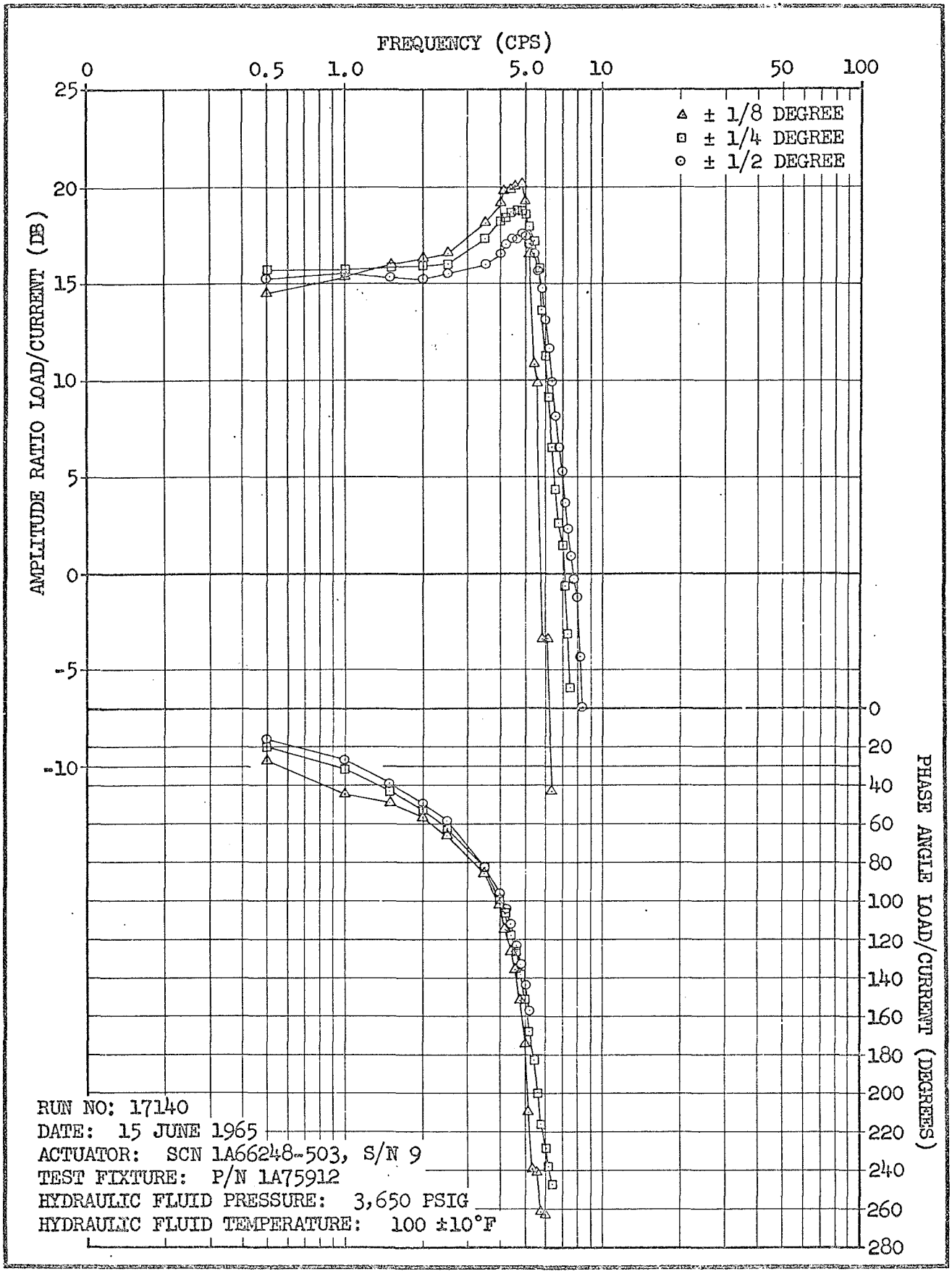


Chart 3-21. Post-Life-Cycle Frequency Response, Load/Current - Test Specimen No. 3

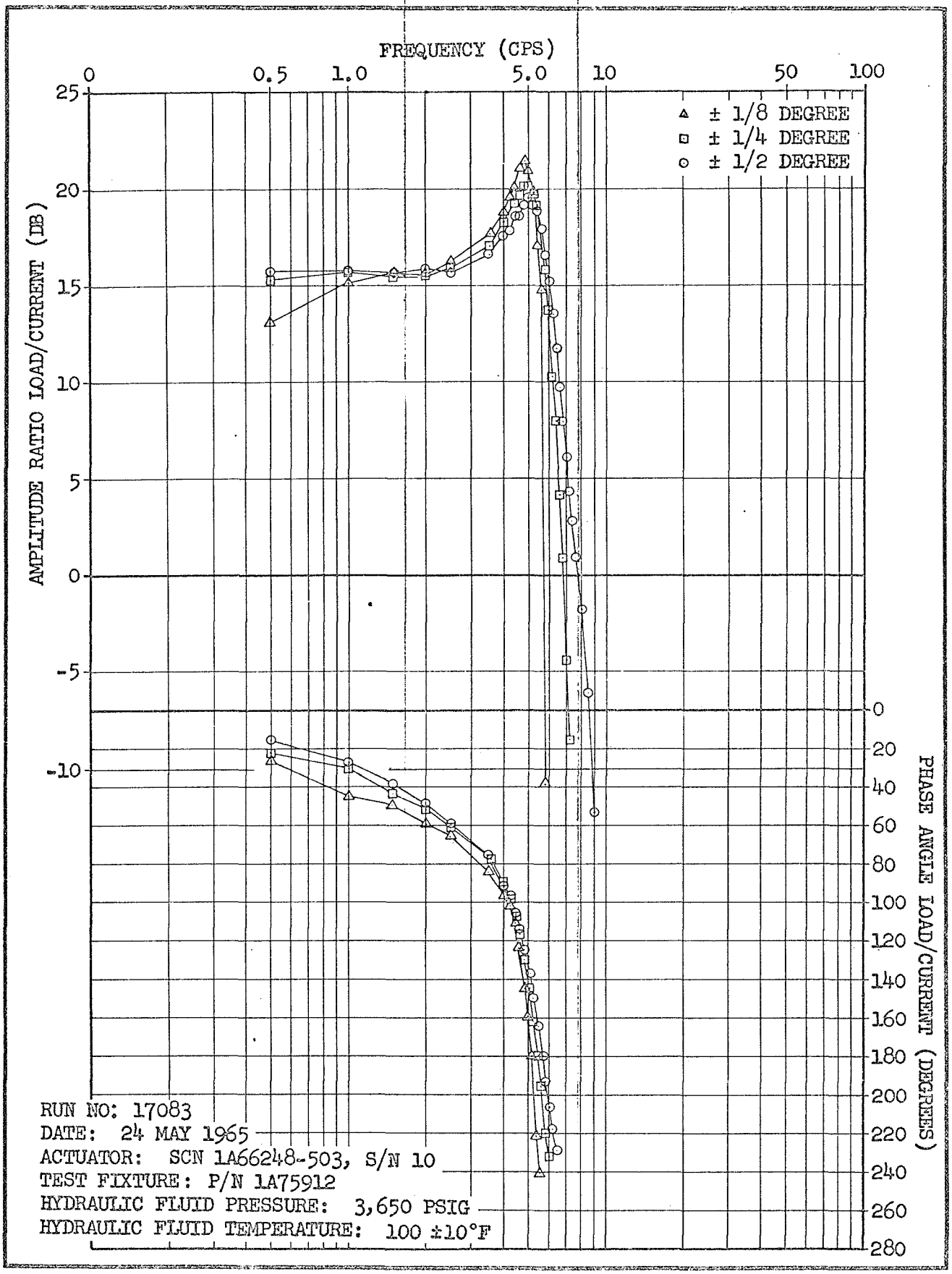


Chart 3-22. Post-Life-Cycle Frequency Response, Load/Current - Test Specimen No. 4

APPENDIX 4

TABLE 4-1. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 2

APR. 21, 1965 9:47 A.M. RUN 17056 FREQUENCY RESPONSE TEST

FREQ.	AMPL VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.5000	.1767	10.76 -194.8	4.397 -7.890	15.16 -202.7	-3.179 -177.7
	.3349	11.01 -192.5	5.185 -4.289	16.19 -196.8	-3.630 -178.7
	.6699	11.17 -193.7	5.097 -1.500	16.26 -195.2	-3.211 -180.3
.9960	.1787	8.286 -205.5	5.722 -12.23	14.00 -217.7	-2.282 -177.9
	.3134	10.93 -208.0	5.765 -1.371	16.70 -199.4	-3.311 -184.3
	.6875	10.89 -200.8	5.380 -.6328	16.27 -201.4	-3.134 -181.7
1.480	.1796	9.942 -212.0	6.374 -7.507	16.31 -219.5	-3.459 -181.4
	.3300	10.42 -214.1	5.991 -4.933	16.41 -219.1	-3.574 -180.3
	.6826	10.54 -212.8	5.791 -1.332	16.34 -214.1	-3.393 -180.9
1.968	.1630	9.367 -222.0	7.239 -7.132	16.60 -229.1	-3.150 -182.8
	.3291	9.677 -224.8	6.690 -3.894	16.36 -228.7	-3.374 -179.6
	.6455	10.14 -223.5	6.336 -2.714	16.47 -226.2	-3.464 -181.1
2.468	.1796	9.106 -232.0	8.068 -5.410	17.17 -237.4	-3.299 -182.3
	.3339	9.507 -233.0	7.325 -3.097	16.82 -236.1	-3.418 -181.5
	.6738	9.821 -234.0	6.824 -2.066	16.64 -236.0	-3.403 -180.6
3.445	.1796	8.365 -254.0	10.23 -4.886	18.59 -258.9	-3.459 -182.2
	.3369	8.769 -255.1	9.197 -2.960	17.95 -258.0	-3.343 -182.0
	.6728	9.053 -256.0	8.620 -2.117	17.67 -258.1	-3.355 -181.4
4.000	.1630	7.759 -271.0	11.98 -5.535	19.74 -276.5	-2.818 -182.6
	.3222	8.115 -271.1	10.66 -4.226	18.78 -275.3	-2.903 -181.8
	.6601	8.248 -272.5	9.941 -2.796	18.18 -275.3	-3.208 -181.9
4.156	.1591	8.012 -282.2	12.66 -6.730	20.68 -289.0	-3.818 -179.1
	.3193	8.225 -279.7	11.40 -3.761	19.63 -283.5	-3.723 -180.6
	.6689	8.074 -280.6	10.62 -2.660	18.69 -283.2	-3.547 -181.5
4.359	.1767	7.475 -290.9	13.22 -7.019	20.69 -297.9	-3.851 -182.2
	.3310	7.808 -286.5	11.96 -4.359	19.77 -290.9	-3.359 -184.1
	.6914	7.175 -290.0	11.34 -3.636	18.52 -293.6	-3.234 -181.8
4.539	.1845	6.269 -303.5	14.25 -6.636	20.52 -310.1	-2.736 -181.4
	.3154	6.865 -300.4	13.16 -5.082	20.03 -305.5	-3.257 -180.7
	.6718	6.765 -298.1	12.22 -4.164	18.99 -302.3	-3.389 -180.9
4.718	.1669	4.406 -317.5	16.08 -10.17	20.48 -327.6	-3.051 -180.4
	.3251	5.647 -310.3	14.24 -6.203	19.88 -316.6	-3.139 -182.6
	.6640	5.754 -307.8	13.24 -5.039	19.00 -312.9	-3.550 -182.0
4.914	.1562	1.492 -331.2	18.76 -14.67	20.25 -345.9	-4.013 -183.3
	.3505	3.593 -321.9	15.76 -7.980	19.35 -329.8	-3.100 -181.1
	.6572	4.136 -318.0	14.64 -6.925	18.78 -324.9	-3.487 -181.8
5.156	.1757	-2.246 -340.2	21.28 -20.86	19.04 -1.085	-3.775 -180.4
	.3339	1.028 -333.1	17.79 -10.11	18.82 -343.2	-3.437 -184.3
	.6806	1.714 -328.4	16.35 -9.222	18.06 -337.6	-3.250 -182.1
5.328	.1826	-12.18 -333.2	29.35 -46.37	17.17 -19.66	-2.896 -182.5
	.3164	-3.322 -343.4	21.20 -16.47	17.88 -359.8	-3.120 -182.1
	.6513	-1.323 -336.4	18.74 -13.01	17.41 -349.4	-3.438 -181.6
5.531	.1591	-6.074 -231.6	20.76 -171.0	14.69 -42.67	-3.784 -184.6
	.3232	-10.22 -341.2	26.78 -32.51	16.56 -13.80	-3.210 -184.1
	.6689	-5.466 -340.8	21.92 -19.92	16.46 -.7304	-3.449 -181.6
5.726	.1669	-2.722 -238.5	13.58 -178.1	10.85 -56.71	-3.193 -179.1
	.3212	-17.27 -262.0	32.32 -123.5	15.04 -25.57	-3.371 -183.7
	.6679	-11.63 -331.2	26.86 -40.07	15.23 -11.30	-3.310 -183.2
5.937	.1552	-.8603 -244.5	8.895 -181.1	8.034 -65.76	-3.790 -181.5
	.3300	-9.909 -226.8	23.48 -168.5	13.58 -35.32	-3.540 -183.3
	.6787	-17.09 -272.1	31.18 -108.0	14.08 -20.14	-3.430 -182.1
6.171	.1826	-1.573 -247.7	8.435 -177.6	6.861 -65.34	-2.995 -182.4
	.3125	-5.494 -230.4	17.02 -175.5	11.53 -46.16	-3.575 -181.5
	.6767	-11.60 -232.8	24.39 -155.7	12.79 -28.53	-3.462 -182.1
6.335	.1611	-.8286 -251.3	3.086 -181.1	2.258 -72.48	-3.034 -184.1
	.3173	-4.261 -237.1	13.80 -175.9	9.541 -53.10	-3.203 -182.8
	.6464	-8.239 -225.9	19.85 -170.6	11.61 -36.65	-3.393 -183.3

TABLE 4-1. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 2 (Continued)

APR. 21, 1965 9:47 A.M. RUN 17056 FREQUENCY RESPONSE TEST

FREQ.	AMPL VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.578	.1591	-.2695 -257.8	.1621 -175.8	-.1074 -73.68	-3.323 -184.1
	.3115	-2.518 -242.2	10.45 -177.1	7.935 -59.33	-3.355 -181.5
	.6728	-6.008 -231.8	15.98 -171.9	9.980 -43.75	-3.295 -182.4
6.703	.1601	.1572 -258.1	-2.727 -185.0	-2.569 -83.22	-3.592 -180.6
	.3222	-2.171 -246.2	8.059 -178.8	5.887 -65 03	-3.415 -181.8
	.6640	-4.360 -234.0	13.00 -174.6	8.645 -48.67	-3.422 -182.6
6.953	.1894	-.5551 -256.7	-1.973 -183.6	-2.529 -80.45	-3.155 -361.2
	.3281	-1.905 -249.6	6.116 -179.3	4.211 -68.98	-3.320 -181.6
	.6435	-3.344 -237.0	10.62 -176.1	7.280 -53.27	-3.267 -183.3
7.125	.1816	-.3818 -257.0	-2.148 -183.3	-2.530 -80.42	-3.676 -184.6
	.3212	-1.462 -251.2	4.317 -179.2	2.854 -70.46	-3.227 -184.2
	.6718	-2.994 -241.1	8.938 -177.1	5.944 -58.28	-3.384 -182.4
7.328	.1591	-.1074 -260.8	-6.520 -182.3	-6.628 -83.26	-3.503 -182.3
	.3203	-1.286 -253.9	2.927 -180.9	1.640 -74.96	-3.440 -182.5
	.6757	-2.641 -242.1	7.347 -177.5	4.705 -59.69	-3.420 -183.4
7.476	.1787	-.7421 -260.5	-5.136 -178.0	-5.878 -78.60	-3.249 -184.4
	.3359	-1.457 -255.0	2.021 -180.1	.5639 -75.21	-3.479 -182.9
	.6728	-2.402 -245.0	6.111 -178.2	3.709 -63.31	-3.458 -183.1
7.679	.1533	-.1669 -262.7	-11.70 -184.4	-11.87 -87.16	-3.686 -183.1
	.3339	-1.376 -257.1	.7163 -181.0	-.6601 -78.19	-3.513 -183.3
	.6777	-2.283 -247.3	4.700 -178.2	2.416 -65.63	-3.404 -182.8
7.898	.1582	-.7260 -264.7	-9.660 -188.1	-10.38 -92.86	-3.267 -181.3
	.3417	-1.944 -258.2	-.3491 -181.7	-2.293 -79.96	-3.311 -183.9
	.6503	-2.073 -251.5	3.073 -178.7	.9995 -70.37	-3.442 -183.1
8.398	.1787	-1.220 -266.9	-12.66 -177.2	-13.88 -84.17	-3.347 -183.3
	.3369	-1.818 -262.1	-3.200 -181.3	-5.019 -83.50	-3.300 -183.9
	.6748	-2.132 -255.0	.7104 -178.9	-1.421 -73.96	-3.355 -183.7
9.062	.1591	-1.897 -271.0	-12.80 -180.0	-14.70 -91.08	-3.103 -184.3
	.3183	-2.349 -264.5	-6.304 -183.6	-8.654 -88.17	-3.332 -184.5
	.6474	-2.067 -261.1	-1.829 -179.3	-3.897 -80.46	-3.303 -183.7
9.406	.1767	-2.107 -268.9	-15.08 -197.7	-17.19 -106.7	-3.409 -185.7
	.3330	-2.231 -267.4	-8.059 -184.8	-10.29 -92.29	-3.521 -184.2
	.6767	-2.407 -263.3	-3.973 -179.2	-6.380 -82.61	-3.343 -183.7
10.25	.1572	-2.338 -276.6	-24.89 -152.8	-27.23 -69.55	-3.248 -184.9
	.3310	-2.619 -267.0	-9.576 -182.1	-12.19 -89.16	-3.400 -185.1
	.6855	-3.032 -267.1	-6.180 -180.7	-9.212 -87.83	-3.426 -184.0
12.00	.1689	-3.199 -277.7	-25.94 -211.3	-29.14 -129.1	-3.178 -185.6
	.3085	-3.090 -276.6	-19.61 -189.4	-22.70 -106.1	-3.501 -185.3
	.6884	-3.659 -280.3	-12.91 -180.4	-16.57 -100.7	-3.492 -184.8
15.09	.1601	-5.655 -286.7	-38.58 -30.65	-44.24 -317.3	-3.503 -186.3
	.3232	-5.864 -286.9	-22.17 -146.4	-28.03 -73.43	-3.432 -186.0
	.6699	-5.918 -285.1	-22.10 -178.0	-28.02 -103.2	-3.410 -186.4
19.76	.1572	-3.464 -293.8	-29.54 -303.3	-38.00 -237.1	-3.466 -188.9
	.3427	-8.570 -297.4	-25.31 -172.5	-33.88 -109.9	-3.454 -188.1
	.6660	-8.609 -297.3	-32.36 -260.3	-40.97 -197.6	-3.465 -188.3

11:13 A.M.

TABLE 4-2. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

APR. 19, 1965 11:05 A.M. RUN 17035 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.4990	.1640	10.04 -198.7	4.147 -8.015	14.19 -206.7	-3.024 -177.5
	.3251	10.50 -196.7	5.242 -4.046	15.74 -200.7	-3.530 -178.8
	.6708	10.84 -195.8	5.361 -1.238	16.20 -197.1	-3.278 -179.6
.9843	.1660	9.526 -213.3	5.864 -8.339	15.39 -221.7	-3.173 -176.3
	.3164	10.14 -210.0	5.879 -3.070	16.02 -213.1	-3.593 -178.7
	.6787	10.36 -206.3	5.665 -.9140	16.03 -207.2	-3.332 -181.4
1.480	.1582	9.178 -220.6	6.303 -7.984	15.48 -228.6	-3.486 -180.1
	.3369	9.458 -220.4	6.124 -3.539	15.58 -224.0	-3.309 -180.6
	.6738	9.963 -218.4	6.055 -1.125	16.01 -219.5	-3.370 -180.6
1.968	.1640	8.440 -232.2	7.249 -2.894	15.69 -235.1	-3.205 -180.0
	.3232	8.982 -230.2	6.536 -1.855	15.52 -232.1	-3.425 -181.2
	.6738	9.433 -228.2	6.555 -2.503	15.98 -230.7	-3.378 -180.9
2.468	.1767	7.735 -241.7	8.332 -6.464	16.06 -248.2	-3.442 -181.5
	.3349	8.242 -239.7	7.742 -2.761	15.98 -242.5	-3.411 -181.3
	.6738	8.793 -238.2	7.308 -2.230	16.10 -240.4	-3.378 -181.1
3.445	.1601	6.485 -262.5	10.96 -6.816	17.45 -269.3	-3.161 -181.3
	.3144	6.976 -259.5	10.04 -3.074	17.02 -262.6	-3.448 -181.4
	.6787	7.657 -260.3	9.152 -1.937	16.81 -262.2	-3.400 -181.2
3.976	.1767	6.373 -277.0	12.46 -5.464	18.84 -282.4	-3.409 -180.3
	.3349	6.713 -275.0	11.41 -3.246	18.12 -278.2	-3.479 -181.4
	.6718	7.178 -276.0	10.53 -2.367	17.71 -278.4	-3.330 -181.3
4.164	.1630	5.756 -288.1	13.57 -7.164	19.33 -295.2	-3.293 -180.3
	.3183	6.500 -282.4	12.25 -3.558	18.75 -286.0	-3.486 -181.6
	.6689	6.756 -282.6	11.21 -2.371	17.97 -284.9	-3.418 -181.7
4.351	.1738	5.518 -294.8	14.41 -5.996	19.93 -300.8	-3.684 -182.3
	.3291	6.185 -291.1	12.95 -3.375	19.14 -294.5	-3.511 -182.3
	.6748	6.020 -289.2	11.99 -3.183	18.01 -292.4	-3.378 -181.4
4.593	.1669	3.902 -306.1	15.84 -7.718	19.75 -313.8	-3.157 -182.4
	.3193	5.169 -301.4	14.20 -4.335	19.37 -305.7	-3.423 -181.1
	.6718	5.391 -299.0	12.86 -3.925	18.27 -302.9	-3.399 -182.0
4.773	.1630	1.990 -318.8	17.93 -10.60	19.92 -329.4	-3.435 -183.3
	.3281	3.675 -311.8	15.44 -5.644	19.12 -317.5	-3.259 -181.7
	.6474	4.219 -307.6	14.06 -5.250	18.28 -312.8	-3.416 -182.2
4.898	.1650	-1.270 -334.3	20.32 -15.62	19.05 -349.9	-3.083 -182.5
	.3144	2.076 -321.4	17.21 -8.011	19.29 -329.4	-3.413 -181.6
	.6816	2.717 -317.7	15.51 -7.097	18.23 -324.8	-3.392 -181.9
5.148	.1787	-4.825 -343.1	23.33 -20.07	18.51 -3.242	-3.506 -184.0
	.3359	-.5722 -334.6	19.27 -9.593	18.69 -344.2	-3.334 -181.5
	.6738	.3208 -328.6	17.49 -9.386	17.81 -338.0	-3.347 -181.8
5.359	.1650	-12.09 -256.8	27.90 -142.3	15.80 -39.23	-3.189 -183.2
	.3271	-5.179 -343.5	22.99 -17.96	17.81 -1.550	-3.274 -181.7
	.6718	-3.047 -337.0	20.21 -13.72	17.17 -350.7	-3.420 -182.3
5.570	.1621	2.964 -249.3	13.51 -172.1	10.54 -61.46	-3.309 -183.8
	.3339	-13.15 -340.3	29.88 -36.37	16.72 -16.75	-3.272 -181.9
	.6826	-7.736 -342.8	24.11 -20.18	16.37 -3.003	-3.417 -182.0
5.703	.1640	-.9262 -257.2	7.023 -176.3	6.097 -73.63	-3.205 -183.4
	.3242	-14.29 -242.4	29.07 -150.3	14.77 -32.80	-3.487 -182.6
	.6767	-14.39 -330.0	29.78 -44.95	15.39 -14.98	-3.300 -182.5
5.906	.1630	-.3173 -262.2	2.673 -175.0	2.355 -77.25	-3.222 -183.2
	.3281	-8.181 -238.3	20.86 -167.2	12.68 -45.52	-3.259 -182.5
	.6591	-16.48 -250.0	30.33 -136.6	13.84 -26.73	-3.417 -182.7
6.140	.1787	-.6396 -259.0	2.395 -178.5	1.756 -77.53	-3.506 -183.7
	.3398	-5.678 -241.8	16.32 -171.9	10.64 -53.71	-3.286 -183.2
	.6474	-11.50 -236.9	24.07 -159.1	12.56 -36.14	-3.425 -182.5
6.351	.1787	-.1425 -263.4	-.3452 -182.9	-.4882 -86.39	-3.216 -181.3
	.3310	-3.689 -245.9	12.56 -175.6	8.875 -61.67	-3.557 -182.0
	.6738	-7.995 -233.8	19.31 -168.5	11.51 -42.38	-3.395 -183.0

TABLE 4-2. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 3 (Continued)

APR. 19, 1965 11:05 A.M. RUN 17035 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.539	.1621	-.3198 -266.6	-7.561 -184.3	7.880 -91.05	-3.555 -183.3
	.3251	-2.595 -251.5	8.417 -177.7	5.822 -69.36	-3.443 -183.2
	.6757	-5.969 -237.4	15.39 -174.1	9.428 -51.65	-3.403 -183.0
6.781	.1582	-.4956 -269.3	-5.418 -178.6	5.914 -88.03	-3.414 -181.2
	.3388	-2.309 -252.8	7.107 -177.8	4.798 -70.69	-3.291 -182.4
	.6679	-4.734 -242.3	12.89 -174.4	8.157 -56.84	-3.396 -182.8
6.960	.1767	-.7504 -265.7	-2.604 -180.0	3.355 -85.74	-3.570 -183.2
	.3427	-2.383 -257.0	5.217 -178.6	2.833 -75.70	-3.354 -182.2
	.6660	-4.267 -243.8	10.62 -176.1	6.359 -60.01	-3.349 -182.5
7.148	.1621	-.9970 -268.2	-6.628 -175.1	7.625 -83.40	-3.521 -182.5
	.3222	-1.651 -262.9	2.458 -178.4	.8066 -81.36	-3.334 -182.7
	.6816	-3.540 -246.4	8.436 -177.1	4.895 -63.61	-3.395 -182.8
7.328	.1640	-.5883 -273.9	-20.99 -359.8	21.58 -273.8	-3.276 -182.8
	.3251	-1.699 -265.0	.9912 -177.8	.7080 -82.85	-3.327 -182.8
	.6708	-2.998 -251.6	6.700 -176.7	3.702 -68.45	-3.338 -182.9
7.546	.1640	-1.646 -272.9	1.542 -103.8	.1035 -16.77	-3.382 -184.0
	.3261	-1.756 -264.9	-.3930 -177.1	2.149 -82.10	-3.355 -183.7
	.6806	-3.088 -253.3	5.486 -176.9	2.398 -70.25	-3.340 -183.4
7.773	.1611	-1.182 -273.4	-8.203 -219.9	9.385 -133.3	-3.396 -182.2
	.3251	-1.795 -266.7	-1.739 -180.3	3.535 -87.08	-3.345 -183.0
	.6777	-2.857 -256.2	4.073 -177.4	1.215 -73.72	-3.335 -183.2
7.898	.1806	-1.706 -269.9	-3.813 -225.8	5.520 -135.7	-3.315 -182.3
	.3378	-2.063 -268.8	-2.165 -179.5	4.229 -88.48	-3.395 -182.9
	.6767	-2.811 -256.5	2.984 -178.3	.1733 -74.84	-3.321 -183.3
8.500	.1630	-1.911 -276.7	-13.91 -158.9	15.82 -75.68	-3.222 -183.4
	.3251	-2.224 -271.4	-6.191 -179.1	8.415 -90.60	-3.345 -184.1
	.6699	-2.790 -263.5	-.1953 -177.7	2.985 -81.29	-3.333 -183.5
9.031	.1748	-1.770 -279.3	-23.28 -33.06	25.05 -312.4	-3.505 -183.0
	.3427	-2.819 -273.6	-5.917 -157.4	8.737 -71.12	-3.270 -183.4
	.6445	-2.792 -266.1	-2.565 -179.4	5.358 -85.62	-3.326 -184.1
9.437	.1621	-3.039 -279.2	-11.25 -14.21	14.29 -293.4	-3.238 -183.0
	.3232	-2.766 -276.3	-10.10 -195.3	12.86 -111.6	-3.398 -183.3
	.6748	-3.401 -270.0	-1.851 -178.8	8.252 -88.91	-3.369 -184.2
10.15	.1621	-3.265 -281.6	-25.57 -127.4	28.84 -49.02	-3.521 -183.2
	.3251	-3.112 -278.9	-15.94 -179.0	19.05 -98.05	-3.381 -183.8
	.6748	-3.291 -271.2	-7.884 -181.6	11.17 -92.91	-3.360 -184.3
12.10	.1611	-4.742 -288.0	-20.46 -260.5	25.21 -188.5	-3.271 -185.0
	.3212	-4.445 -285.5	-17.88 -208.3	22.33 -133.8	-3.459 -185.5
	.6689	-4.931 -282.2	-14.34 -179.2	19.27 -101.4	-3.422 -185.0
15.14	.1611	-6.680 -294.2	-28.07 -50.99	34.75 -345.2	-3.486 -185.7
	.3222	-6.263 -294.0	-18.45 -278.1	24.71 -212.2	-3.459 -186.1
	.6689	-6.753 -291.8	-24.77 -174.0	31.53 -105.9	-3.439 -186.4
19.76	.1816	-9.685 -304.7	-26.02 -46.51	35.70 -351.2	-3.537 -187.8
	.3183	-9.624 -303.4	-30.96 -120.9	40.58 -64.40	-3.404 -188.0
	.6621	-9.400 -304.2	-29.02 -276.6	38.42 -220.8	-3.491 -188.3

11:59 A.M.

TABLE 4-3. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 4

APR. 20, 1965 9:15 A.M. RUN 17042 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.5092	.1582	10.56 -197.3	4.030 -6.074	14.60 -203.4	-3.414 -177.2
	.3486	10.54 -194.5	4.815 -3.687	15.35 -198.2	-3.147 -180.4
	.6728	10.92 -194.3	4.916 -1.394	15.83 -195.7	-3.244 -180.1
1.003	.1748	10.40 -206.5	5.383 -3.316	15.78 -209.8	-3.916 -179.2
	.3320	10.54 -204.5	5.439 -4.609	15.98 -209.1	-3.554 -178.9
	.6953	10.40 -205.2	5.198 -1.035	15.60 -206.3	-3.216 -180.6
1.480	.1787	9.479 -217.0	5.843 -7.164	15.32 -224.2	-3.475 -181.1
	.3369	9.782 -216.3	5.637 -4.371	15.41 -220.6	-3.411 -180.7
	.6767	10.20 -215.3	5.591 -.8125	15.80 -216.1	-3.365 -180.4
1.968	.1611	8.999 -226.2	6.599 -4.984	15.59 -231.2	-3.574 -181.4
	.3242	9.231 -225.8	6.386 -3.523	15.61 -229.4	-3.398 -180.3
	.6767	9.620 -224.6	6.015 -2.304	15.63 -226.9	-3.382 -180.6
2.468	.1787	8.430 -234.5	7.632 -5.125	16.06 -239.7	-3.410 -181.9
	.3378	8.652 -234.1	7.132 -2.464	15.78 -236.6	-3.403 -180.6
	.6777	9.128 -234.1	6.617 -2.417	15.74 -236.5	-3.361 -180.8
3.445	.1816	7.498 -251.6	9.731 -4.589	17.22 -256.2	-3.365 -181.5
	.3164	7.796 -250.2	9.161 -3.328	16.95 -253.5	-3.414 -181.6
	.6601	7.907 -252.9	8.581 -1.820	16.48 -254.8	-3.357 -181.6
3.898	.1562	7.937 -263.2	11.50 -5.601	19.43 -268.8	-3.664 -181.6
	.3496	7.641 -263.2	10.44 -3.539	18.08 -266.8	-3.308 -181.5
	.6640	7.846 -265.4	9.870 -1.890	17.71 -267.3	-3.410 -181.8
4.125	.1787	7.420 -268.8	11.97 -4.402	19.39 -273.2	-3.475 -183.8
	.3369	7.478 -269.9	11.05 -3.136	18.52 -273.1	-3.395 -182.5
	.6816	7.266 -273.2	10.45 -2.574	17.72 -275.7	-3.349 -182.0
4.375	.1748	7.429 -279.6	12.85 -4.894	20.28 -284.5	-3.698 -181.9
	.3320	7.442 -279.7	11.85 -2.945	19.30 -282.7	-3.504 -182.1
	.6718	7.078 -280.2	11.26 -3.144	18.34 -283.3	-3.364 -181.5
4.570	.1591	7.001 -288.4	14.08 -5.855	21.08 -294.3	-3.680 -182.7
	.3271	6.800 -287.1	12.79 -4.300	19.59 -291.4	-3.355 -182.7
	.6748	6.557 -290.1	12.12 -3.582	18.67 -293.6	-3.386 -181.6
4.726	.1572	6.467 -300.8	15.08 -7.023	21.55 -307.8	-3.645 -181.9
	.3427	6.384 -299.4	13.82 -4.410	20.21 -303.8	-3.437 -181.5
	.6757	5.810 -299.7	13.13 -5.117	18.94 -304.9	-3.334 -182.3
4.937	.1835	4.538 -318.4	16.40 -7.839	20.93 -326.3	-3.112 -182.0
	.3125	4.782 -313.0	15.43 -5.957	20.21 -319.0	-3.394 -181.2
	.6845	4.304 -311.1	14.47 -7.039	18.77 -318.1	-3.345 -182.5
5.132	.1611	1.315 -337.8	19.25 -11.96	20.57 -349.8	-3.291 -183.6
	.3125	2.785 -326.5	17.23 -8.054	20.01 -334.5	-3.356 -181.2
	.6748	2.518 -322.2	16.23 -8.968	18.75 -331.1	-3.370 -181.8
5.312	.1826	-3.498 -347.7	22.78 -20.23	19.28 -7.953	-3.287 -183.6
	.3173	-.6381 -340.2	19.75 -12.28	19.11 -352.5	-3.312 -183.0
	.6523	-.1318 -332.1	18.35 -12.34	18.22 -344.5	-3.394 -181.9
5.578	.1777	-13.83 -297.4	31.56 -96.85	17.72 -34.31	-3.198 -181.4
	.3330	-5.311 -346.4	23.42 -21.44	18.11 -7.914	-3.308 -181.8
	.6689	-4.214 -338.0	21.52 -20.92	17.30 -358.9	-3.333 -182.0
5.703	.1591	-1.701 -252.4	14.14 -173.0	12.44 -65.54	-3.467 -180.6
	.3232	-15.74 -312.5	32.37 -74.18	16.63 -26.70	-3.372 -183.0
	.6640	-10.06 -331.9	26.38 -39.47	16.31 -11.39	-3.388 -182.2
5.882	.1562	..7788 -256.2	6.982 -176.6	7.761 -72.87	-3.558 -181.3
	.3398	-9.694 -243.2	24.49 -155.6	14.79 -38.98	-3.420 -182.0
	.6787	-15.84 -283.2	30.95 -99.78	15.11 -23.01	-3.328 -182.6
6.148	.1816	-.1889 -257.7	6.553 -177.7	6.364 -75.44	-3.205 -183.2
	.3125	-4.712 -241.3	17.22 -169.2	12.51 -50.61	-3.320 -181.8
	.6748	-11.28 -243.6	24.85 -148.9	13.57 -32.63	-3.312 -182.7
6.367	.1767	..3295 -260.6	3.303 -174.6	3.632 -75.37	-3.538 -181.1
	.3388	-3.725 -242.5	14.26 -173.0	10.54 -55.60	-3.428 -183.4
	.6728	-7.563 -236.1	19.80 -163.6	12.23 -39.76	-3.317 -182.5
6.585	.1796	.3696 -262.7	-1.108 -177.4	-.7382 -80.14	-3.362 -181.5
	.3291	-2.287 -250.4	10.77 -175.1	8.482 -65.55	-3.494 -182.5
	.6699	-5.003 -236.6	15.58 -170.7	10.58 -47.44	-3.304 -182.7

TABLE 4-3. ACCEPTANCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 4 (Continued)

APR. 20, 1965 9:15 A.M. RUN 17042 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.703	.1640	.4526 -264.8	-3.304 -189.7	-2.851 -94.58	-3.276 -183.6
	.3212	-1.524 -254.5	7.385 -175.9	5.860 -70.54	-3.388 -183.5
	.6708	-4.016 -241.0	12.91 -173.9	8.902 -54.98	-3.411 -183.0
6.960	.1757	.2377 -267.1	-3.688 -187.5	-3.450 -94.68	-3.553 -181.8
	.3349	-1.342 -254.7	6.282 -177.4	4.939 -72.22	-3.264 -182.8
	.6708	-2.998 -242.4	10.73 -175.2	7.735 -57.75	-3.312 -182.9
7.171	.1572	.4208 -269.1	-7.907 -209.2	-7.486 -118.3	-3.431 -181.4
	.3388	-1.355 -256.8	4.270 -176.7	2.915 -73.51	-3.283 -182.6
	.6679	-2.456 -246.1	8.838 -176.2	6.382 -62.38	-3.323 -183.1
7.296	.1630	.1547 -268.9	-9.800 -164.1	-9.645 -73.09	-3.435 -184.2
	.3242	-1.298 -260.3	2.964 -182.4	1.666 -82.80	-3.443 -183.5
	.6767	-2.403 -249.6	7.043 -176.4	4.639 -66.08	-3.338 -183.2
7.515	.1611	.2587 -269.8	-8.621 -213.0	-8.362 -122.9	-3.291 -182.3
	.3232	-1.182 -262.7	.3842 -177.6	-.7983 -80.42	-3.415 -182.9
	.6738	-2.134 -252.5	5.461 -177.2	3.326 -69.77	-3.395 -183.3
7.703	.1787	-.3378 -268.4	-7.409 -186.6	-7.747 -95.07	-3.506 -183.9
	.3330	-1.082 -262.8	-.1464 -185.2	-1.229 -88.09	-3.479 -183.3
	.6757	-2.097 -254.3	4.278 -176.9	2.181 -71.31	-3.394 -183.4
7.968	.1787	-.2402 -271.8	-11.94 -172.3	-12.18 -84.17	-3.313 -184.2
	.3271	-2.310 -257.2	.8398 -193.3	-1.470 -90.57	-2.627 -174.4
	.6914	-1.950 -256.7	3.025 -176.8	1.075 -73.60	-3.422 -183.3
8.562	.1601	-.8325 -273.2	-13.92 -189.1	-14.75 -102.4	-3.450 -184.5
	.3378	-1.658 -265.9	-3.753 -178.1	-5.412 -84.09	-3.462 -183.9
	.6855	-2.351 -262.5	-.0986 -177.9	-2.449 -80.50	-3.395 -183.8
9.187	.1640	-1.279 -273.8	-16.78 -223.9	-18.06 -137.7	-3.452 -184.3
	.3183	-1.611 -271.3	-6.619 -180.3	-8.230 -91.68	-3.439 -183.5
	.6699	-2.236 -266.8	-2.432 -178.6	-4.668 -85.55	-3.388 -183.5
9.468	.1621	-1.604 -276.8	-22.79 -110.9	-24.40 -27.78	-3.486 -185.0
	.3212	-2.084 -273.3	-8.498 -191.6	-10.58 -105.0	-3.378 -183.4
	.6708	-2.595 -269.1	-4.604 -178.4	-7.199 -87.61	-3.398 -184.3
10.31	.1591	-1.965 -279.7	-17.17 -226.7	-19.13 -146.5	-3.503 -184.9
	.3183	-2.707 -275.9	-11.68 -197.1	-14.39 -113.1	-3.332 -183.9
	.6591	-3.123 -271.4	-7.316 -179.7	-10.44 -91.25	-3.338 -184.2
12.03	.1611	-3.234 -284.3	-41.06 -241.1	-44.29 -165.4	-3.521 -185.9
	.3222	-3.831 -283.0	-16.65 -177.8	-20.49 -100.9	-3.396 -185.6
	.6679	-4.331 -279.9	-14.36 -177.9	-18.69 -97.84	-3.418 -185.0
15.20	.1611	-5.020 -291.0	-22.37 -71.11	-27.39 -2.210	-3.415 -185.7
	.3222	-5.234 -291.9	-13.69 -59.77	-18.92 -351.7	-3.370 -186.3
	.6708	-6.008 -289.3	-24.63 -211.6	-30.64 -141.0	-3.405 -186.4
19.76	.1572	-8.321 -300.8	-23.66 -307.1	-31.98 -248.0	-3.576 -189.0
	.3378	-7.919 -300.5	-36.71 -63.78	-44.63 -4.316	-3.513 -188.7
	.6845	-9.100 -298.5	-35.63 -210.3	-44.73 -148.9	-3.403 -188.2

10:47 A.M.

TABLE 4-4. PRE-ENVIRONMENTAL FREQUENCY RESPONSE AT ROOM TEMPERATURE, TEST SPECIMEN NO. 3

SEP. 2, 1965 10:23 A.M. RUN 17272 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5078	.1611	5.914 -198.3	-12.99 -20.74	-7.083 -219.1	-3.848 -179.4
	.3193	6.397 -194.9	-9.959 -7.976	-3.562 -202.9	-3.928 -180.0
	.6601	6.665 -194.3	-10.12 -2.929	-3.457 -197.3	-3.931 -180.4
.9997	.1601	5.752 -209.5	-9.222 -15.02	-3.469 -224.5	-3.731 -179.9
	.3242	6.149 -205.3	-9.453 -2.554	-3.303 -207.9	-3.996 -181.2
	.6494	6.309 -207.4	-9.778 -2.281	-3.469 -209.7	-3.885 -180.7
1.488	.1640	5.433 -218.7	-9.190 -8.667	-3.757 -227.4	-3.826 -182.2
	.3291	5.542 -219.0	-9.130 -5.765	-3.587 -224.8	-3.881 -181.9
	.6601	5.806 -217.2	-9.615 -3.210	-3.808 -220.4	-3.841 -181.6
1.976	.1669	4.853 -229.1	-8.076 -11.19	-3.222 -240.3	-3.638 -181.9
	.3359	4.947 -227.5	-8.750 -4.117	-3.803 -231.6	-3.820 -183.8
	.6660	5.276 -227.0	-9.102 -2.804	-3.825 -229.8	-3.872 -182.9
2.484	.1630	4.489 -238.3	-6.799 -4.695	-2.309 -243.0	-3.912 -184.5
	.3281	4.636 -239.5	-7.778 -2.960	-3.142 -242.4	-3.859 -183.5
	.6611	4.533 -239.2	-8.295 -2.910	-3.762 -242.1	-3.820 -183.3
3.468	.1777	3.522 -265.2	-4.641 -6.179	-1.118 -271.4	-3.926 -184.9
	.3398	3.521 -261.3	-5.822 -4.125	-2.300 -265.4	-3.863 -185.4
	.6572	3.533 -260.7	-6.596 -2.558	-3.062 -263.3	-3.896 -186.4
4.007	.1767	3.112 -284.5	-3.160 -4.140	-.0473 -288.6	-4.184 -186.3
	.3378	2.492 -277.1	-4.086 -4.234	-1.594 -281.3	-4.024 -186.7
	.6650	2.701 -277.8	-5.148 -2.625	-2.447 -280.5	-3.994 -188.3
4.171	.1835	2.613 -294.8	-2.250 -7.730	.3623 -302.5	-3.942 -189.5
	.3232	2.131 -285.4	-3.399 -4.433	-1.268 -289.8	-4.104 -188.4
	.6718	1.910 -285.5	-4.295 -3.578	-2.385 -289.0	-3.921 -188.1
4.367	.1718	2.399 -300.7	-1.464 -6.140	.9350 -306.9	-4.217 -190.5
	.3261	1.758 -294.2	-2.662 -4.660	-.9033 -298.9	-4.156 -189.6
	.6826	.8642 -294.5	-3.572 -4.187	-2.708 -298.7	-4.036 -189.1
4.562	.1728	4.868 -345.8	-2.861 -5.976	2.006 -351.8	-4.168 -190.9
	.3242	.8935 -306.5	-1.601 -5.734	-.7080 -312.2	-4.336 -188.6
	.6796	.0131 -303.9	-2.449 -5.093	-2.436 -309.0	-4.083 -189.0
4.773	.1767	-14.52 -238.9	12.29 -128.8	-2.229 -7.710	-3.179 -180.5
	.3320	-1.594 -331.7	.5639 -349.0	-1.030 -328.8	-4.317 -189.1
	.6777	-1.578 -314.8	-1.140 -6.394	-2.718 -321.2	-4.267 -189.2
4.992	.1816	-7.007 -146.3	4.094 -261.6	-2.913 -48.03	-3.737 -180.4
	.3574	-5.489 -326.5	2.576 -18.89	-2.912 -345.4	-3.962 -189.2
	.6416	-3.627 -324.9	.5639 -8.402	-3.063 -333.3	-4.354 -189.0
5.171	.1835	.3623 -312.7	-2.150 -79.00	-1.788 -31.78	-3.854 -183.1
	.3203	-6.235 -6.902	4.047 -.1289	-2.187 -7.031	-4.084 -191.8
	.6425	-5.080 -333.7	2.444 -13.39	-2.635 -347.1	-4.357 -189.6
5.375	.1738	-9.301 -9.414	5.804 -60.76	-3.497 -70.17	-4.329 -186.9
	.3339	-5.151 -48.60	4.600 -336.5	-.5502 -25.15	-4.236 -187.0
	.6513	-8.721 -353.3	5.356 -14.11	-3.365 -7.476	-4.406 -187.9
5.585	.1738	-2.337 -332.5	-6.546 -87.94	-8.884 -60.46	-4.148 -192.1
	.3261	-18.62 -325.0	15.85 -77.05	-2.771 -42.09	-4.311 -187.4
	.6650	-14.69 -338.7	10.29 -42.21	-4.402 -26.92	-4.252 -188.1
5.757	.1533	-2.554 -255.3	-7.737 -206.9	-10.29 -102.3	-4.212 -189.0
	.3232	-12.66 -256.9	6.828 -168.6	-5.838 -65.58	-4.235 -189.7
	.6621	-18.65 -290.7	13.14 -99.33	-5.510 -30.03	-4.248 -188.9
5.937	.1533	-7.395 -319.0	-4.479 -156.3	-11.87 -115.3	-4.212 -192.6
	.3261	-8.063 -263.8	-1.988 -172.3	-10.05 -76.21	-4.156 -189.5
	.6748	-14.76 -248.2	7.819 -149.8	-6.949 -38.18	-4.074 -189.8
6.171	.1679	-.5200 -23.18	-8.203 -335.0	-8.723 -205.9	-4.477 -191.5
	.3447	-7.549 -267.1	-4.715 -180.0	-12.26 -87.14	-4.252 -190.7
	.6894	-11.66 -242.3	3.037 -164.2	-8.630 -46.56	-3.958 -188.9
6.375	.1689	-2.615 -291.7	-21.31 -8.023	-23.93 -299.7	-4.396 -188.5
	.3369	-6.434 -275.8	-9.648 -178.6	-16.08 -94.53	-4.446 -189.9
	.6943	-9.702 -242.3	-.3442 -169.7	-10.04 -52.07	-4.170 -189.7

TABLE 4-4. PRE-ENVIRONMENTAL FREQUENCY RESPONSE AT ROOM TEMPERATURE, TEST SPECIMEN NO. 3 (Continued)

SEP. 2, 1965 10:23 A.M. RUN 17272 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.585	.1699	-8.824 -60.23	.4038 -34.20	-8.420 -94.43	-4.131 -191.0
	.3261	-1.625 -265.0	-23.27 -339.5	-24.90 -244.6	-4.058 -192.1
	.6689	-8.105 -248.2	-3.835 -174.7	-11.94 -62.92	-4.166 -190.6
6.765	.1679	-4.122 -155.1	-.5014 -337.0	-4.624 -132.2	-4.417 -192.4
	.3466	-5.003 -266.9	-18.74 -238.9	-23.74 -145.9	-4.106 -192.1
	.6855	-7.684 -249.0	-6.111 -175.4	-13.79 -64.52	-4.026 -191.0
6.984	.1679	-1.423 -299.5	-24.20 -61.09	-25.62 -.6250	-4.477 -194.5
	.3447	-7.525 -320.8	-5.563 -81.05	-13.08 -41.90	-4.246 -191.1
	.6796	-7.055 -251.6	-8.116 -176.9	-15.17 -68.55	-4.024 -191.9
7.179	.1669	-.6860 -341.9	-4.793 -46.96	-5.479 -28.91	-4.588 -193.6
	.3486	-5.273 -238.3	-9.498 -281.1	-14.77 -159.4	-4.178 -192.4
	.6533	-6.739 -256.3	-9.919 -179.3	-16.65 -75.66	-4.185 -192.7
7.359	.1708	-3.799 -352.5	-19.47 -12.07	-23.27 -4.644	-4.387 -191.3
	.3398	-1.709 -268.5	-14.44 -349.6	-16.15 -258.1	-4.187 -193.4
	.6591	-6.733 -261.1	-11.87 -176.1	-18.60 -77.30	-4.147 -192.8
7.546	.1689	-2.283 -268.5	-18.39 -7.820	-20.67 -276.3	-4.695 -191.4
	.3261	-6.641 -270.2	-12.44 -279.2	-19.08 -189.4	-4.483 -192.3
	.6884	-6.647 -259.3	-12.56 -181.3	-19.20 -80.71	-4.206 -193.5
7.796	.1738	-4.584 -297.5	-9.058 -106.5	-13.64 -44.14	-4.476 -192.9
	.3378	-4.910 -243.7	-13.37 -315.5	-18.29 -199.3	-4.113 -193.3
	.6767	-6.850 -263.6	-14.23 -177.5	-21.08 -81.25	-4.163 -193.9
8.187	.1689	-.8422 -226.3	-4.548 -328.8	-5.390 -195.2	-4.427 -192.5
	.3476	-4.727 -294.7	-8.549 -66.11	-13.27 -.8789	-4.278 -194.7
	.6513	-6.826 -263.4	-15.65 -177.5	-22.47 -81.01	-4.099 -194.5
8.562	.1660	-3.245 -237.6	-7.211 -306.9	-10.45 -184.6	-4.458 -195.6
	.3300	-24.97 -304.0	15.41 -150.9	-9.568 -94.98	-4.440 -191.6
	.6787	-6.711 -265.0	-18.50 -182.5	-25.21 -87.62	-4.208 -196.1
9.312	.1601	-8.732 -294.0	-26.02 -84.80	-34.75 -18.86	-4.584 -196.7
	.3300	-14.42 -295.8	.0000 -158.3	-14.42 -94.17	-4.670 -193.0
	.6855	-7.316 -265.6	-20.94 -183.8	-28.26 -89.47	-4.157 -196.1
9.500	.1630	-8.747 -284.4	30.52 -273.7	21.77 -198.1	-4.942 -197.5
	.3320	-9.466 -276.6	-4.746 -265.8	-14.21 -182.4	-4.754 -196.4
	.6923	-7.519 -273.[illegible]	-22.60 -169.6	-30.12 -82.73	-4.373 -197.0
10.28	.1542	-14.14 -348.0	.2758 -119.7	-13.87 -107.8	-5.274 -198.9
	.3447	-9.346 -284.9	-15.13 -220.6	-24.48 -145.5	-4.775 -197.7
	.6953	-8.256 -272.3	-25.23 -211.5	-33.49 -123.8	-4.433 -198.0
12.32	.1777	-10.83 -219.9	-8.745 -288.6	-19.57 -148.5	-5.137 -199.1
	.3261	-9.361 -286.2	-41.06 -187.0	-50.42 -113.2	-4.890 -202.6
	.6855	-9.604 -277.9	-31.70 -232.3	-41.31 -150.3	-4.714 -201.8
15.31	.1591	-12.14 -62.50	.4233 -26.56	-11.72 -89.06	-5.665 -204.4
	.3427	-12.34 -286.3	-10.18 -320.1	-22.53 -246.4	-5.425 -205.6
	.6777	-11.44 -290.1	20.93 -349.6	9.487 -279.7	-5.310 -207.3
20.00	.1630	-14.24 -305.4	-20.56 -117.7	-34.80 -63.14	-6.580 -210.5
	.3330	-13.87 -307.5	-21.08 -53.04	-34.96 -.5585	-6.424 -212.5
	.6787	-14.48 -296.9	-42.21 -359.6	-56.70 -296.6	-6.240 -212.9

11:23 A.M.

TABLE 4-5. POST-ENVIRONMENTAL FREQUENCY RESPONSE AT ROOM TEMPERATURE, TEST SPECIMEN NO. 3

SEP. 9, 1965 11:29 A.M. RUN 17284 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.4990	.1572	-.6723 -194.0	-4.673 -200.0	-5.346 -34.00	-3.504 -181.5
	.3349	-.0756 -195.8	-4.227 -186.4	-4.302 -22.30	-3.393 -180.5
	.6777	.6274 -194.7	-5.113 -183.8	-4.485 -18.59	-3.497 -180.6
.9960	.1689	-1.354 -211.2	-3.492 -188.5	-4.847 -39.75	-3.770 -180.5
	.3232	-.4296 -210.2	-4.165 -181.5	-4.594 -31.82	-3.652 -180.1
	.6884	.2783 -207.8	-5.007 -182.7	-4.729 -30.58	-3.484 -180.7
1.488	.1787	-1.961 -220.0	-1.775 -189.6	-3.737 -49.71	-3.378 -181.7
	.3291	-1.127 -220.6	-3.989 -184.7	-5.117 -45.39	-3.598 -180.0
	.6601	-.1684 -218.4	-4.432 -183.6	-4.600 -42.10	-3.530 -180.9
1.980	.1796	-2.884 -230.7	-1.197 -191.8	-4.082 -62.60	-3.522 -181.4
	.3320	-1.625 -229.9	-2.897 -183.9	-4.523 -53.89	-3.504 -180.4
	.6679	-.8813 -229.0	-3.777 -183.0	-4.659 -52.00	-3.470 -180.8
2.480	.1562	-3.414 -241.7	.5454 -188.5	-2.868 -70.33	-3.521 -181.6
	.3320	-2.331 -240.0	-2.278 -184.4	-4.610 -64.51	-3.537 -180.6
	.6640	-1.247 -238.2	-3.188 -183.6	-4.436 -61.85	-3.521 -181.2
3.464	.1718	-4.322 -263.4	2.271 -187.7	-2.050 -91.20	-3.587 -181.5
	.3242	-3.188 -261.0	.0756 -183.7	-3.112 -84.81	-3.469 -181.5
	.6679	-2.314 -261.5	-1.399 -182.3	-3.714 -83.87	-3.496 -181.5
4.007	.1748	-5.502 -282.7	4.473 -183.8	-1.028 -106.5	-3.375 -183.2
	.3193	-3.642 -278.3	1.750 -185.7	-1.892 -104.1	-3.671 -181.8
	.6650	-2.792 -276.4	-.1596 -182.6	-2.952 -99.09	-3.479 -181.0
4.171	.1523	-5.586 -291.7	5.806 -192.5	.2197 -124.2	-3.813 -180.4
	.3330	-4.046 -286.4	2.146 -185.5	-1.899 -111.9	-3.513 -180.6
	.6708	-3.339 -284.0	.6103 -182.1	-2.729 -106.1	-3.428 -181.4
4.359	.1679	-6.224 -302.2	6.570 -190.6	.3466 -132.8	-3.820 -182.0
	.3437	-4.282 -295.2	2.688 -183.8	-1.592 -119.0	-3.388 -180.9
	.6669	-3.786 -293.3	1.563 -184.3	-2.222 -117.6	-3.581 -181.6
4.546	.1699	-7.786 -314.5	8.176 -189.3	.3891 -143.9	-3.686 -182.7
	.3203	-5.506 -305.2	4.555 -187.0	-.9506 -132.3	-3.626 -181.7
	.6679	-4.539 -301.5	2.303 -183.9	-2.236 -125.5	-3.482 -181.4
4.765	.1572	-13.01 -334.2	11.85 -199.9	-1.152 -174.1	-3.248 -182.4
	.3310	-6.998 -316.9	5.962 -188.8	-1.035 -145.8	-3.540 -181.0
	.6582	-5.739 -310.2	3.824 -185.7	-1.915 -136.0	-3.555 -181.7
4.960	.1679	-19.13 -339.5	17.71 -208.9	-1.423 -188.4	-3.787 -183.1
	.3457	-9.253 -329.4	7.845 -190.9	-1.408 -160.4	-3.553 -181.1
	.6630	-7.436 -322.6	5.444 -187.0	-1.992 -149.6	-3.582 -181.9
5.171	.1572	-10.51 -262.7	-6.777 -3.578	-17.28 -266.3	-3.394 -180.5
	.3359	-13.58 -343.6	11.31 -194.8	-2.265 -178.5	-3.421 -181.5
	.6669	-10.06 -334.1	7.509 -187.4	-2.557 -161.6	-3.496 -182.4
5.382	.1806	-11.90 -266.0	-4.814 -2.152	-16.71 -262.1	-3.283 -181.8
	.3300	-21.33 -347.9	17.71 -207.1	-3.611 -195.1	-3.470 -183.0
	.6689	-13.77 -342.9	10.48 -194.0	-3.295 -177.0	-3.461 -181.7
5.562	.1816	-11.41 -263.3	-10.45 -7.390	-21.86 -270.7	-3.269 -182.3
	.3164	-23.76 -352.7	17.79 -325.5	-5.966 -218.3	-3.377 -181.8
	.6406	-20.33 -345.9	16.05 -295.0	-4.283 -191.0	-3.445 -182.5
5.742	.1728	-10.97 -262.8	-13.15 -2.214	-24.13 -265.0	-3.603 -180.7
	.3164	-19.08 -238.2	11.54 -348.1	-7.540 -226.3	-3.645 -182.6
	.6933	-29.05 -311.3	23.35 -249.5	-5.695 -200.8	-3.518 -182.6
5.945	.1728	-11.15 -266.9	-13.80 -43.98	-24.95 -310.9	-3.306 -181.9
	.3232	-15.43 -243.9	4.859 -353.6	-10.57 -242.5	-3.389 -182.0
	.6621	-24.14 -236.0	17.07 -337.1	-7.068 -213.2	-3.567 -182.5
6.171	.1679	-11.08 -264.9	-15.56 -331.7	-26.64 -236.7	-3.787 -181.5
	.3466	-14.74 -249.6	2.531 -356.2	-12.21 -245.9	-3.396 -182.8
	.6630	-19.12 -232.8	10.49 -348.7	-8.630 -221.5	-3.564 -182.5
6.367	.1679	-11.64 -263.9	-23.52 -265.7	-35.16 -169.7	-3.787 -182.6
	.3447	-13.11 -254.9	-1.191 -355.0	-14.30 -249.9	-3.562 -181.8
	.6718	-16.39 -238.6	6.145 -351.8	-10.25 -230.5	-3.492 -182.1

TABLE 4-5. POST-ENVIRONMENTAL FREQUENCY RESPONSE AT ROOM TEMPERATURE, TEST SPECIMEN NO. 3 (Continued)

SEP. 9, 1965 11:29 A.M. RUN 17284 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
6.562	.1738	-12.13 -269.0	-26.84 -50.81	-38.98 -319.8	-3.587 -183.9
	.3281	-12.25 -259.1	-5.406 -357.7	-17.65 -256.9	-3.504 -181.9
	.6708	-14.91 -243.9	2.338 -354.7	-12.57 -238.6	-3.466 -182.5
6.820	.1728	-11.89 -271.2	-21.02 -66.48	-32.91 -337.7	-3.306 -183.0
	.3251	-12.60 -263.4	-6.245 -357.5	-18.85 -260.9	-3.496 -181.8
	.6699	-14.17 -244.8	.1928 -354.9	-13.97 -239.7	-3.552 -183.0
6.968	.1728	-12.29 -270.9	-17.10 -48.88	-29.39 -319.8	-3.306 -182.7
	.3212	-12.58 -265.9	-9.429 -8.031	-22.01 -273.9	-3.450 -183.5
	.6611	-13.23 -250.5	-1.691 -355.3	-14.93 -245.8	-3.542 -182.4
7.179	.1718	-12.86 -271.0	-22.50 -263.5	-35.36 -174.6	-3.716 -183.3
	.3251	-12.80 -266.3	-11.59 -6.593	-24.40 -272.9	-3.555 -183.4
	.6621	-13.13 -253.4	-3.550 -358.6	-16.68 -252.1	-3.479 -183.1
7.359	.1787	-13.65 -271.6	-31.59 -178.5	-45.24 -90.26	-3.506 -183.7
	.3310	-12.62 -269.3	-11.10 -2.570	-23.73 -271.8	-3.436 -182.6
	.6640	-12.81 -253.9	-5.530 -358.2	-18.34 -252.1	-3.504 -183.2
7.539	.1767	-13.33 -270.6	-9.543 -349.4	-22.87 -260.1	-3.632 -182.1
	.3359	-13.09 -271.6	-13.53 -9.394	-26.62 -281.0	-3.428 -183.2
	.6660	-12.84 -258.6	-6.660 -356.3	-19.50 -255.0	-3.564 -182.8
7.765	.1757	-13.97 -272.5	-7.604 -2.750	-21.58 -275.2	-3.649 -182.0
	.3320	-13.10 -269.2	-16.67 -1.714	-29.77 -270.9	-3.564 -183.5
	.6669	-12.80 -261.6	-7.604 -357.5	-20.40 -259.1	-3.475 -182.9
7.968	.1728	-14.32 -276.2	-24.60 -59.50	-38.93 -335.7	-3.374 -183.7
	.3242	-13.12 -272.1	-14.98 -6.085	-28.11 -278.2	-3.477 -182.5
	.6640	-12.76 -261.5	-8.898 -355.5	-21.66 -257.1	-3.555 -183.0
8.500	.1552	-14.78 -276.7	-23.22 -2.468	-38.00 -279.1	-3.503 -182.0
	.3330	-13.72 -275.7	-21.33 -19.59	-35.06 -295.3	-3.453 -183.5
	.6679	-13.27 -266.6	-12.04 -1.015	-25.31 -267.7	-3.487 -183.5
9.125	.1718	-15.08 -271.4	-3.382 -120.2	-18.46 -31.73	-3.355 -184.5
	.3212	-13.92 -276.2	-22.41 -42.17	-36.33 -318.4	-3.450 -184.1
	.6738	-13.45 -271.0	-12.91 -3.765	-26.36 -274.7	-3.483 -183.2
9.531	.1748	-15.22 -281.6	-23.80 -322.8	-39.03 -244.5	-3.698 -182.6
	.3349	-14.83 -277.7	-29.82 -67.99	-44.66 -345.7	-3.521 -184.4
	.6650	-13.76 -272.0	-17.28 -356.5	-31.04 -268.6	-3.531 -184.0
10.18	.1669	-15.41 -281.6	-23.22 -259.1	-38.64 -180.7	-3.672 -183.1
	.3417	-14.86 -283.3	-29.96 -119.3	-44.83 -42.72	-3.579 -184.6
	.6582	-14.12 -276.2	-18.32 -8.851	-32.45 -285.1	-3.483 -184.3
12.34	.1542	-18.81 -290.3	-25.10 -145.7	-43.91 -76.12	-3.540 -186.1
	.3300	-16.90 -287.7	-24.08 -94.43	-40.98 -22.21	-3.487 -185.3
	.6601	-16.04 -285.2	-26.52 -42.18	-42.56 -327.4	-3.496 -185.0
15.25	.1748	-20.92 -299.5	-18.06 -12.12	-38.98 -311.7	-3.423 -185.8
	.3183	-18.36 -298.8	-22.28 -331.9	-40.64 -270.8	-3.566 -185.6
	.6728	-18.39 -293.1	-38.27 -284.6	-56.67 -217.8	-3.555 -185.8
20.00	.1738	-24.03 -309.8	45.39 -187.8	21.36 -137.6	-3.636 -188.3
	.3271	-22.07 -308.8	-22.27 -336.5	-44.35 -285.3	-3.574 -187.7
	.6748	-21.08 -306.7	-23.52 -263.3	-44.60 -210.1	-3.598 -188.0

12:25 P.M.

TABLE 4-6. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT 0°F, TEST SPECIMEN NO. 3

SEP. 7, 1965 1:51 P.M. RUN 17280 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5126	.1728	-2.951 -195.5	-3.418 -16.15	-6.370 -211.7	-3.137 -179.0
	.3222	-2.517 -193.3	-1.618 -6.289	-4.135 -199.6	-3.486 -181.1
	.6630	-2.519 -193.6	-1.529 -2.160	-4.048 -195.8	-3.344 -181.1
1.003	.1640	-3.444 -210.7	.5932 -12.76	-2.851 -223.4	-3.276 -179.9
	.3417	-2.648 -207.6	-.8115 -2.167	-3.460 -209.8	-3.421 -180.8
	.6708	-2.724 -206.3	-1.324 -3.433	-4.048 -209.7	-3.208 -181.4
1.492	.1748	-3.693 -220.8	.6445 -13.20	-3.049 -234.0	-3.342 -181.2
	.3261	-3.355 -220.8	-.2319 -5.468	-3.587 -226.3	-3.310 -182.0
	.6816	-3.215 -218.8	-.8310 -2.074	-4.046 -220.9	-3.217 -182.1
1.980	.1748	-3.919 -232.8	1.533 -7.441	-2.386 -240.2	-3.375 -182.1
	.3339	-3.991 -231.2	-.0805 -4.996	-4.072 -236.2	-3.176 -183.3
	.6621	-3.853 -230.2	-.3051 -2.945	-4.158 -233.1	-3.226 -182.9
2.488	.1777	-4.612 -244.1	1.823 -5.554	-2.789 -249.6	-3.132 -184.3
	.3349	-4.556 -241.1	1.009 -5.480	-3.547 -246.5	-3.150 -183.7
	.6660	-4.677 -240.2	.3427 -4.089	-4.334 -244.3	-3.149 -184.0
3.468	.1708	-5.491 -268.3	4.548 -3.714	-.9433 -272.1	-3.234 -186.5
	.3251	-5.738 -261.2	2.930 -3.226	-2.807 -264.4	-3.157 -186.7
	.6708	-5.906 -258.3	2.115 -2.371	-3.791 -260.6	-3.129 -186.8
4.000	.1689	-6.918 -282.7	6.508 -6.992	-.4101 -289.7	-3.370 -189.2
	.3427	-5.898 -272.2	4.299 -4.269	-1.599 -276.5	-3.261 -187.5
	.6689	-6.542 -269.8	3.466 -2.582	-3.076 -272.4	-3.149 -188.6
4.187	.1718	-7.181 -289.2	7.376 -6.789	.1953 -296.0	-3.554 -188.2
	.3320	-6.440 -279.4	5.176 -4.480	-1.263 -283.8	-3.120 -188.7
	.6611	-6.687 -273.4	4.223 -2.937	-2.463 -276.4	-3.278 -189.0
4.359	.1699	-7.910 -301.3	8.535 -6.617	.6250 -308.0	-3.284 -189.9
	.3144	-6.407 -287.9	5.992 -3.402	-.4150 -291.3	-3.247 -188.8
	.6777	-6.738 -286.5	4.793 -3.097	-1.944 -283.6	-3.228 -189.4
4.593	.1699	-8.034 -313.1	9.329 -6.652	1.294 -319.8	-3.620 -190.2
	.3212	-6.938 -295.3	6.990 -5.027	.0522 -300.3	-3.477 -189.1
	.6748	-7.176 -289.1	5.698 -3.792	-1.478 -292.9	-3.300 -190.6
4.757	.1523	-11.82 -337.3	12.86 -14.66	1.047 -351.9	-3.256 -188.6
	.3222	-7.932 -3 8.4	8.218 -5.277	.2866 -313.7	-3.601 -190.4
	.6621	-7.779 -295.8	6.816 -5.218	-.9628 -301.0	-3.444 -190.5
4.960	.1630	-17.60 -346.7	17.28 -25.95	-.3173 -12.68	-3.779 -186.9
	.3291	-9.416 -319.2	9.988 -7.230	.5722 -326.4	-3.598 -191.2
	.6601	-9.018 -307.9	8.322 -7.480	-.6958 -315.4	-3.569 -190.7
5.187	.1748	-18.20 -248.5	11.21 -162.4	-6.994 -51.03	-3.342 -187.1
	.3183	-12.09 -337.4	12.48 -9.945	.3906 -347.3	-3.504 -190.1
	.6640	-10.61 -321.3	10.03 -9.468	-.5820 -330.7	-3.533 -190.3
5.367	.1708	-13.26 -254.6	-2.653 -188.9	-15.91 -83.61	-3.603 -190.4
	.3164	-17.34 -349.0	16.76 -19.65	-.5810 -8.699	-3.486 -189.9
	.6738	-13.71 -332.1	12.66 -14.75	-1.058 -346.8	-3.642 -190.0
5.601	.1708	-12.39 -262.0	-11.63 -186.7	-24.03 -88.85	-3.234 -188.3
	.3125	-31.01 -330.4	28.22 -60.35	-2.792 -30.77	-3.521 -189.8
	.6650	-18.06 -341.8	16.25 -22.50	-1.811 -4.335	-3.572 -190.2
5.750	.1689	-12.50 -268.4	-18.27 -159.0	-30.78 -67.49	-3.128 -190.3
	.3398	-19.00 -250.7	10.84 -157.4	-8.161 -48.17	-3.320 -189.3
	.6425	-25.46 -33 .9	22.27 -49.00	-3.190 -19.96	-3.518 -190.1
5.984	.1679	-13.11 -263.1	-14.69 -196.1	-27.80 -99.28	-3.420 -192.2
	.3369	-18.29 -243.0	8.823 -175.7	-9.467 -58.83	-3.411 -191.2
	.6699	-27.17 -255.4	22.09 -138.4	-5.071 -33.98	-3.458 -190.6
6.171	.1708	-12.39 -267.7	-32.46 -265.0	-44.86 -172.7	-3.200 -189.8
	.3115	-15.92 -248.7	1.972 -181.9	-13.95 -70.66	-3.494 -191.4
	.6767	-21.23 -242.3	13.80 -162.9	-7.435 -45.22	-3.369 -190.4
6.375	.1689	-12.93 -272.5	-22.28 -99.74	-35.21 -12.29	-3.233 -192.6
	.3369	-15.16 -253.3	-.5991 -177.8	-15.76 -71.23	-3.437 -191.0
	.6777	-19.18 -240.2	9.878 -173.2	-9.307 -53.47	-3.377 -191.8

TABLE 4-6. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT 0°F, TEST SPECIMEN NO. 3 (Continued)

SEP. 7, 1965 1:51 P.M. RUN 17280 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
6.570	.1689	-13.39 -270.0	-17.38 -228.8	-30.78 -138.8	-3.704 -191.8
	.3457	-14.69 -255.1	-4.216 -181.2	-18.91 -76.32	-3.464 -191.9
	.6787	-17.35 -246.1	5.197 -176.7	-12.15 -62.88	-3.408 -191.8
6.757	.1699	-13.21 -274.2	-17.61 -61.89	-30.83 -336.1	-3.387 -191.2
	.3173	-14.39 -259.2	-8.613 -180.5	-23.00 -79.81	-3.404 -192.3
	.6875	-16.51 -247.9	3.550 -176.9	-12.96 -64.89	-3.309 -193.5
6.984	.1630	-12.85 -267.2	-25.57 -170.6	-38.43 -77.89	-3.676 -192.2
	.3320	-14.75 -261.7	-7.220 -175.7	-21.97 -77.43	-3.410 -194.2
	.6806	-16.58 -250.5	1.031 -179.5	-15.55 -70.12	-3.392 -193.3
7.195	.1630	-13.08 -266.1	-31.36 -275.0	-44.45 -181.2	-3.642 -192.4
	.3310	-14.87 -263.4	-8.103 -176.1	-22.97 -79.58	-3.418 -194.4
	.6699	-16.03 -252.7	-.7553 -178.7	-16.78 -71.49	-3.367 -194.0
7.351	.1689	-14.38 -274.5	-18.32 -247.9	-32.71 -162.5	-3.704 -192.5
	.3505	-15.23 -261.6	-10.74 -170.7	-25.97 -72.33	-3.406 -194.6
	.6513	-16.11 -254.8	-2.498 -177.5	-18.61 -72.45	-3.360 -194.8
7.570	.1718	-14.53 -277.3	-20.82 -9.468	-35.36 -286.7	-3.355 -193.5
	.3154	-14.59 -260.6	-9.988 -199.3	-24.58 -100.0	-3.592 -195.3
	.6962	-15.89 -257.8	-4.360 -181.8	-20.25 -79.74	-3.461 -194.5
7.789	.1679	-14.60 -273.7	-20.56 -246.4	-35.16 -160.1	-3.721 -193.6
	.3447	-15.36 -269.3	-12.64 -159.7	-28.00 -69.09	-3.438 -194.8
	.6640	-15.87 -259.5	-5.042 -180.4	-20.91 -79.99	-3.479 -195.9
7.984	.1630	-15.51 -272.5	-28.94 -93.39	-44.45 -5.933	-3.710 -195.7
	.3310	-15.93 -266.7	-10.56 -183.8	-26.49 -90.58	-3.521 -196.0
	.6669	-15.91 -261.8	-7.307 -178.4	-23.22 -80.30	-3.465 -195.7
8.484	.1650	-15.61 -271.6	-22.92 -188.9	-38.53 -100.6	-3.708 -196.6
	.3349	-15.56 -268.8	-17.05 -172.6	-32.61 -81.48	-3.638 -197.3
	.6738	-16.31 -252.9	-8.826 -184.7	-25.14 -87.75	-3.576 -197.6
8.929	.1679	-15.76 -283.2	-22.92 -8.992	-38.68 -292.2	-3.488 -195.7
	.3320	-15.63 -269.5	-18.06 -206.1	-33.70 -115.7	-3.732 -199.0
	.6757	-16.69 -267.3	-12.48 -173.7	-29.17 -81.09	-3.571 -198.4
9.593	.1582	-16.58 -284.4	-27.60 -156.3	-44.19 -80.83	-3.698 -199.2
	.3173	-15.56 -270.8	-28.62 -288.3	-44.19 -199.2	-3.786 -199.1
	.6845	-16.70 -269.0	-15.06 -177.8	-31.77 -86.94	-3.726 -199.5
10.25	.1611	-16.05 -284.4	-28.29 -21.26	-44.35 -305.7	-3.746 -198.0
	.3144	-16.87 -275.4	-17.69 -187.7	-34.56 -103.2	-3.867 -200.0
	.6748	-17.10 -269.9	-17.36 -186.3	-34.47 -96.22	-3.787 -201.1
12.18	.1728	-18.88 -281.2	-20.00 -309.8	-38.89 -231.0	-4.217 -201.3
	.3271	-17.77 -284.0	-26.64 -36.38	-44.42 -320.3	-4.214 -203.8
	.6718	-18.85 -278.2	-20.93 -178.8	-39.79 -97.62	-4.166 -205.1
15.14	.1630	-20.31 -292.1	-24.08 -249.3	-44.40 -181.4	-4.935 -206.5
	.3251	-19.74 -288.5	-24.60 -246.2	-44.35 -174.7	-5.002 -209.6
	.6816	-20.94 -283.1	30.37 -143.7	9.436 -66.86	-4.742 -211.0
20.03	.1601	-24.19 -299.6	-20.00 -327.6	-44.19 -267.3	-5.859 -214.3
	.3154	-23.20 -297.1	-26.84 -332.7	-50.04 -269.9	-6.019 -215.3
	.6611	-23.59 -293.8	-26.84 -340.8	-50.44 -238.7	-6.027 -217.3

2:51 P.M.

TABLE 4-7. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT +275°F, TEST SPECIMEN NO. 3

SEP. 3, 1965 10:01 A.M. RUN 17274 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5058	.1708	-2.319 -192.0	-.8154 -8.281	-3.134 -200.3	-5.429 -180.4
	.3212	-2.349 -194.0	-1.631 -2.96	-3.981 -196.9	-5.376 -180.7
	.6601	-2.463 -194.6	-1.567 -2.238	-4.030 -196.8	-5.388 -180.6
.9997	.1796	-2.312 -207.8	-.4418 -6.566	-2.753 -214.4	-5.511 -179.8
	.3330	-2.696 -206.9	-1.188 -5.691	-3.885 -212.6	-5.400 -181.1
	.6806	-2.764 -206.4	-1.171 -1.042	-3.936 -207.5	-5.415 -181.1
1.488	.1718	-3.255 -218.3	.4208 -10.55	-2.834 -228.9	-5.433 -180.9
	.3300	-3.230 -222.8	-.7788 -6.265	-4.009 -227.0	-5.325 -181.0
	.6533	-3.139 -219.5	-.6577 -1.996	-3.797 -221.5	-5.381 -181.5
1.980	.1748	-3.842 -232.2	.5126 -10.63	-3.330 -242.8	-5.207 -182.8
	.3330	-3.649 -232.2	.1147 -4.066	-3.535 -236.3	-5.332 -182.2
	.6708	-3.771 -230.4	-.2563 -2.457	-4.028 -232.9	-5.296 -182.2
2.484	.1757	-4.278 -245.7	-4.839 -14.14	-9.118 -259.8	-5.237 -183.1
	.3330	-4.377 -244.0	-10.01 -52.08	-14.39 -296.1	-5.249 -183.6
	.6542	-4.244 -243.8	-16.15 -216.1	-20.39 -100.0	-5.346 -183.0
3.468	.1679	-5.920 -279.2	-5.164 -347.3	-11.08 -266.5	-5.393 -185.1
	.3359	-5.673 -273.0	-11.43 -66.10	-17.10 -333.1	-5.393 -184.0
	.6650	-6.059 -265.0	-16.80 -330.9	-22.85 -236.0	-5.440 -184.6
3.968	.1845	-8.262 -303.9	3.947 -184.0	-4.314 -127.9	-5.327 -187.2
	.3320	-6.879 -290.9	-2.312 -29.24	-9.192 -320.2	-5.424 -185.4
	.6650	-7.136 -281.7	-8.452 -156.4	-15.58 -78.17	-5.488 -185.8
4.195	.1689	-10.11 -317.2	4.965 -51.79	-5.206 -9.046	-5.688 -187.3
	.3251	-8.103 -303.7	-2.701 -25.12	-10.80 -328.8	-5.496 -187.2
	.6591	-7.629 -290.2	-9.299 -39.86	-16.92 -330.1	-5.599 -186.4
4.390	.1621	-11.93 -331.2	9.045 -154.3	-2.891 -125.6	-5.618 -187.2
	.3222	-8.786 -302.4	.0708 -196.0	-8.715 -138.4	-5.698 -187.0
	.6708	-8.596 -297.5	-6.545 -349.7	-15.14 -287.2	-5.618 -185.8
4.585	.1689	-15.51 -334.7	-1.289 -243.9	-16.80 -218.6	-5.530 -184.4
	.3173	-11.25 -321.6	-11.02 -197.0	-22.28 -158.6	-5.678 -186.0
	.6689	-9.775 -307.3	-17.67 -334.9	-27.45 -282.3	-5.617 -186.4
4.789	.1630	-26.39 -308.4	27.04 -57.06	.6518 -5.503	-5.401 -185.1
	.3193	-13.89 -333.7	8.762 -193.1	-5.137 -171.8	-5.737 -187.1
	.6816	-11.41 -316.0	-.4770 -89.53	-11.89 -45.62	-5.695 -186.5
4.976	.1611	-22.07 -211.5	16.61 -297.3	-5.459 -148.9	-5.726 -187.3
	.3222	-17.90 -345.3	6.224 -174.5	-11.68 -159.9	-5.726 -186.9
	.6601	-14.10 -323.1	-3.586 -35.44	-17.69 -358.5	-5.672 -186.4
5.148	.1816	-16.76 -230.1	6.789 -50.23	-9.973 -280.4	-5.466 -185.2
	.3251	-25.34 -342.9	10.45 -132.2	-14.88 -115.1	-5.661 -187.2
	.6552	-17.93 -327.7	-3.320 -201.2	-21.25 -169.0	-5.804 -186.5
5.398	.1650	-12.09 -244.0	9.045 -196.4	-3.046 -80.52	-5.706 -185.8
	.3281	-25.91 -245.8	16.82 -264.8	-9.089 -150.6	-5.363 -188.8
	.6494	-21.79 -320.5	6.565 -197.7	-15.22 -158.2	-5.708 -186.0
5.562	.1699	-12.55 -244.0	11.03 -150.6	-1.524 -34.66	-5.611 -186.3
	.3408	-21.60 -223.3	13.67 -168.0	-7.933 -31.30	-6.032 -183.4
	.6748	-26.40 -294.9	12.61 -309.4	-13.79 -244.4	-5.673 -186.9
5.734	.1650	-12.73 -255.0	14.70 -2.937	1.968 -258.0	-5.600 -185.4
	.3144	-18.79 -233.7	14.78 -10.99	-4.008 -244.7	-6.005 -182.5
	.6855	-24.44 -257.0	13.85 -176.2	-10.59 -73.32	-5.691 -186.8
5.945	.1835	-13.44 -254.7	10.81 -194.0	-2.623 -88.80	-5.472 -187.0
	.3144	-16.90 -233.2	9.729 -2.093	-7.173 -235.3	-5.965 -187.1
	.6826	-21.44 -244.1	7.627 -89.26	-13.81 -333.4	-5.579 -186.7
6.140	.1748	-12.59 -257.9	10.01 -143.7	-2.580 -41.66	-5.725 -188.5
	.3515	-16.64 -241.9	7.925 -132.6	-8.714 -14.60	-5.303 -185.0
	.6474	-19.39 -241.6	5.582 -113.7	-13.80 -355.4	-5.590 -187.1
6.367	.1884	-13.45 -260.8	7.207 -110.7	-6.248 -11.59	-5.044 -189.0
	.3320	-15.66 -245.2	4.589 -24.14	-11.07 -269.3	-5.047 -185.9
	.6845	-18.52 -243.5	1.171 -150.4	-17.34 -33.93	-5.574 -187.8

TABLE 4-7. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT +275°F, TEST SPECIMEN NO. 3 (Continued)

SEP. 3, 1965 10:01 A.M. RUN 17274 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
6.617	.1660	-13.48 -261.1	9.935 -171.6	-3.547 -72.84	-5.494 -189.9
	.3339	-15.38 -243.3	5.945 -221.7	-9.440 -105.0	-5.508 -188.7
	.6523	-17.48 -244.4	2.666 -81.81	-14.81 -326.2	-5.552 -187.9
6.812	.1796	-13.69 -260.5	9.310 -214.9	-4.389 -115.5	-5.684 -189.5
	.3300	-15.16 -249.1	5.489 -112.5	-9.671 -1.683	-5.395 -189.3
	.6542	-17.13 -247.4	1.379 -73.15	-15.75 -320.5	-5.540 -188.0
7.000	.1660	-13.97 -264.6	11.51 -65.28	-2.464 -329.9	-5.302 -189.5
	.3251	-14.57 -251.3	6.363 -291.0	-8.211 -182.3	-5.577 -189.0
	.6699	-16.96 -249.8	2.272 -9.300	-14.69 -259.1	-5.644 -188.0
7.171	.1816	-13.56 -263.1	14.02 -123.5	.4550 -26.67	-5.491 -190.8
	.3291	-14.82 -253.3	10.04 -256.2	-4.770 -149.6	-5.569 -189.6
	.6708	-16.62 -249.6	5.579 -82.68	-11.04 -332.3	-5.566 -189.0
7.375	.1660	-14.23 -262.8	13.15 -12.09	-1.087 -274.9	-5.708 -190.8
	.3437	-14.64 -253.5	7.492 -146.9	-7.155 -40.52	-5.444 -189.2
	.6601	-16.31 -251.7	3.379 -145.0	-12.93 -36.71	-5.584 -188.8
7.593	.1689	-14.65 -266.5	12.37 -317.8	-2.283 -224.4	-5.557 -191.1
	.3212	-15.20 -257.4	7.026 -11.52	-8.173 -268.9	-5.599 -190.5
	.6542	-16.67 -254.4	2.718 -335.9	-13.95 -230.3	-5.627 -189.9
7.796	.1708	-13.97 -271.2	5.508 -210.8	-8.470 -122.1	-5.456 -190.7
	.3222	-15.07 -257.7	1.381 -51.18	-13.69 -308.9	-5.671 -190.4
	.6572	-16.36 -256.9	-3.394 -74.96	-19.75 -331.8	-5.705 -189.5
7.992	.1767	-15.32 -271.7	.2758 -355.9	-15.04 -267.6	-5.728 -188.3
	.3291	-15.40 -260.5	-3.521 -196.3	-18.93 -96.89	-5.623 -191.2
	.6699	-16.61 -260.6	-10.25 -41.23	-26.87 -301.8	-5.625 -189.9
8.476	.1699	-14.44 -270.0	6.653 -131.0	-7.786 -41.14	-5.398 -190.8
	.3203	-15.48 -263.3	2.093 -49.93	-13.38 -313.2	-5.682 -191.3
	.6513	-16.72 -263.1	-2.468 -55.23	-19.18 -318.3	-5.735 -190.6
9.218	.1855	-15.47 -274.7	9.172 -201.2	-6.299 -116.0	-5.478 -192.5
	.3183	-15.75 -264.1	4.883 -48.63	-10.86 -312.8	-5.665 -192.1
	.6767	-16.77 -261.5	-.5371 -225.1	-17.31 -126.6	-5.508 -192.1
9.531	.1699	-16.85 -281.1	15.44 -243.3	-1.406 -164.5	-5.559 -193.4
	.3164	-16.92 -269.4	10.14 -314.0	-6.778 -223.5	-5.706 -193.6
	.6777	-17.51 -263.7	4.129 -291.2	-13.38 -195.0	-5.582 -193.0
10.21	.1718	-15.66 -277.3	13.16 -261.5	-2.498 -178.9	-5.871 -193.0
	.3300	-17.48 -273.9	9.477 -13.31	-8.011 -287.3	-5.610 -193.7
	.6533	-17.48 -265.6	3.223 -220.5	-14.25 -126.1	-5.654 -193.5
12.30	.1728	-17.67 -278.6	.3686 -340.1	-17.30 -258.7	-5.871 -195.4
	.3359	-18.63 -280.7	-4.438 -93.14	-23.07 -13.85	-5.801 -196.8
	.6689	-19.04 -275.3	-9.656 -240.1	-28.70 -155.5	-5.911 -196.4
15.25	.1621	-20.26 -279.1	21.02 -96.34	.7553 -15.50	-6.380 -201.5
	.3261	-20.85 -285.2	15.31 -115.0	-5.534 -40.33	-6.506 -199.4
	.6748	-20.44 -285.0	8.750 -255.1	-11.69 -180.1	-6.177 -201.3
20.00	.1708	-22.48 -294.0	1.804 -29.41	-20.67 -323.4	-6.949 -204.9
	.3291	-23.57 -296.3	-5.264 -138.2	-28.84 -74.58	-6.949 -206.1
	.6738	-23.76 -294.6	-10.59 -237.9	-34.35 -172.5	-6.918 -205.9

10:57 A.M.

TABLE 4-8. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT -35°F, TEST SPECIMEN NO. 3

SEP. 8, 1965 9:55 A.M. RUN 17281 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5092	.1748	-1.829 -22.61	-3.582 -18.96	-5.412 -41.57	-2.832 -182.3
	.3242	-2.023 -19.23	-2.597 -7.312	-4.621 -26.54	-2.718 -179.5
	.6689	-1.921 -16.83	-1.961 -3.796	-3.882 -20.63	-2.758 -180.1
1.007	.1591	-1.137 -42.50	-3.106 -11.45	-4.244 -53.95	-2.875 -179.6
	.3164	-2.045 -31.31	-1.761 -15.15	-3.807 -46.47	-2.717 -182.1
	.6738	-1.812 -32.09	-1.784 -3.058	-3.597 -35.15	-2.657 -180.9
1.488	.1630	-2.309 -57.24	-1.316 -17.38	-3.626 -74.63	-2.856 -181.5
	.3339	-2.583 -48.73	-.7495 -9.546	-3.333 -58.28	-2.518 -182.7
	.6650	-2.684 -45.73	-1.169 -4.429	-3.853 -50.16	-2.574 -181.9
1.980	.1679	-3.882 -72.23	.3867 -13.78	-3.496 -86.01	-2.674 -182.7
	.3417	-3.350 -62.72	-.2963 -7.492	-3.647 -70.21	-2.430 -183.8
	.6523	-3.645 -56.49	-.6577 -3.976	-4.304 -60.47	-2.559 -183.7
2.484	.1699	-5.441 -80.33	2.568 -13.13	-2.873 -93.47	-2.460 -185.6
	.3310	-4.241 -77.46	.2465 -7.023	-3.995 -84.49	-2.632 -184.5
	.6621	-4.367 -65.45	.0000 -5.671	-4.367 -71.12	-2.661 -185 0
3.468	.1611	-7.448 -107.3	4.682 -11.78	-2.766 -119.1	-2.654 -187.4
	.3232	-6.368 -98.77	2.898 -6.425	-3.469 -105.2	-2.648 -188.1
	.6650	-6.059 -84.54	1.778 -3.945	-4.280 -88.49	-2.640 -187.6
4.015	.1611	-10.03 -120.6	7.117 -17.50	-2.912 -138.1	-2.498 -187.0
	.3173	-7.378 -107.1	4.375 -7.171	-3.003 -114.3	-2.728 -188.2
	.6621	-6.938 -92.46	3.183 -5.214	-3.754 -97.67	-2.679 -189.7
4.179	.1591	-9.924 -131.4	8.025 -17.42	-1.897 -148.8	-3.140 -187.9
	.3271	-7.456 -111.1	5.153 -7.867	-2.302 -118.9	-2.829 -190.4
	.6699	-7.170 -99.58	3.843 -4.933	-3.326 -104.5	-2.868 -189.7
4.351	.1591	-13.11 -132.5	10.08 -28.42	-3.029 -160.9	-2.683 -188.7
	.3134	-8.122 -121.5	6.191 -7.039	-1.931 -128.6	-3.011 -189.5
	.6728	-7.746 -102.5	4.656 -6.363	-3.089 -108.8	-2.757 -190.3
4.593	.1611	-15.40 -150.9	12.64 -27.86	-2.766 -178.8	-2.922 -187.2
	.3212	-8.980 -122.3	7.036 -9.687	-1.944 -131.9	-2.815 -190.9
	.6630	-8.093 -109.9	5.568 -6.925	-2.524 -116.9	-2.957 -191.2
4.765	.1562	-16.12 -152.2	14.11 -39.08	-2.006 -191.3	-3.264 -187.9
	.3398	-9.444 -132.4	8.062 -10.10	-1.381 -142.5	-3.066 -190.0
	.6503	-8.449 -117.9	6.491 -7.113	-1.958 -125.0	-3.064 -191.2
5.000	.1611	-21.42 -109.3	16.25 -115.4	-5.169 -224.7	-3.034 -187.2
	.3183	-11.47 -138.8	10.12 -14.92	-1.352 -153.8	-2.934 -191.2
	.6582	-9.594 -126.0	7.825 -9.324	-1.768 -135.4	-3.011 -191.7
5.164	.1601	-11.83 -97.45	-7.856 -156.9	-19.68 -254.3	-3.125 -189.8
	.3095	-13.12 -152.1	12.16 -18.95	-.9545 -171.0	-3.291 -189.8
	.6748	-10.93 -135.8	9.302 -11.69	-1.628 -147.5	-3.083 -191.8
5.398	.1611	-11.88 -94.17	-22.92 -167.6	-34.80 -261.8	-3.034 -191.9
	.3144	-16.35 -157.3	15.20 -29.55	-1.153 -186.9	-3.190 -190.3
	.6669	-13.15 -147.8	11.55 -14.76	-1.604 -162.5	-3.140 -191.6
5.562	.1621	-12.36 -102.9	-12.95 -172.8	-25.31 -275.8	-2.793 -189.6
	.3203	-23.47 -142.3	20.72 -67.10	-2.750 -209.4	-2.880 -190.2
	.6513	-16.12 -157.8	14.51 -22.20	-1.614 -180.1	-3.256 -190.7
5.742	.1767	-12.08 -97.37	-19.08 -177.5	-31.17 -274.9	-3.011 -192.8
	.3291	-21.61 -99.14	17.46 -123.4	-4.150 -222.5	-2.980 -191.1
	.6562	-20.41 -152.4	18.06 -42.06	-2.348 -194.5	-3.074 -191.0
5.984	.1542	-12.15 -107.2	-22.28 -71.52	-34.43 -178.7	-3.107 -191.6
	.3330	-17.59 -81.80	9.079 -158.6	-8.510 -240.4	-2.916 -192.0
	.6650	-26.02 -108.2	21.97 -104.9	-4.040 -213.2	-2.913 -191.2
6.171	.1806	-13.30 -97.05	-16.47 -224.5	-29.78 -321.5	-2.684 -193.1
	.3339	-15.71 -83.44	2.988 -165.0	-12.72 -248.4	-2.925 -193.1
	.6757	-22.63 -72.75	16.68 -153.9	-5.958 -226.6	-2.781 -191.8
6.367	.1572	-13.01 -100.2	-21.58 -270.5	-34.59 -10.80	-2.829 -194.4
	.3378	-15.51 -88.45	.8554 -166.3	-14.65 -254.7	-2.806 -192.9
	.6738	-19.49 -71.66	11.23 -165.2	-8.266 -236.8	-2.844 -192.6

TABLE 4-8. TEMPERATURE ENVIRONMENTAL FREQUENCY RESPONSE AT -35°F, TEST SPECIMEN NO. 3 (Continued)

SEP. 8, 1965 9:55 A.M. RUN 17281 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1		LOAD/PIST POS.		LOAD/1		1/VSIG	
6.585	.1718	-12.24	-107.2	-32.66	-108.4	-44.91	-215.7	-3.151	-193.8
	.3339	-14.69	-87.44	-5.104	-175.5	-19.79	-262.9	-2.998	-194.4
	.6708	-17.68	-76.28	5.791	-166.6	-11.29	-242.9	-2.918	-193.9
6.796	.1757	-13.06	-105.3	-32.04	-335.6	-45.10	-80.96	-3.127	-195.3
	.3320	-14.50	-90.12	-7.496	-176.1	-22.00	-266.3	-3.030	-195.0
	.6738	-17.01	-78.98	3.670	-171.3	-13.34	-250.3	-2.920	-194.0
7.000	.1748	-13.46	-105.5	-31.59	-359.6	-45.05	-105.1	-3.142	-195.6
	.3261	-14.19	-98.04	-7.010	-168.4	-21.20	-266.4	-3.049	-195.0
	.6914	-16.06	-80.93	.6040	-172.2	-15.46	-253.1	-2.980	-195.3
7.179	.1728	-13.83	-107.8	-31.12	-67.67	-44.95	-175.5	-3.205	-195.2
	.3222	-14.63	-99.16	-10.13	-169.1	-24.76	-268.3	-3.116	-195.7
	.6855	-15.84	-81.96	-1.416	-174.4	-17.25	-256.3	-3.079	-195.9
7.343	.1611	-14.52	-108.2	-23.80	-242.6	-38.33	-350.9	-2.959	-196.0
	.3164	-14.62	-97.33	-11.48	-180.9	-26.10	-278.2	-2.957	-195.9
	.6503	-15.69	-84.85	-3.482	-173.4	-19.17	-258.2	-3.037	-197.0
7.578	.1816	-14.76	-111.6	-24.60	-254.1	-39.37	-5.859	-3.041	-196.7
	.3134	-14.53	-100.8	-13.28	-179.4	-27.82	-280.3	-3.018	-196.5
	.6787	-15.90	-87.88	-4.648	-172.9	-20.55	-260.8	-3.115	-196.8
7.765	.1591	-15.61	-113.8	-22.60	-170.3	-38.22	-284.2	-2.952	-195.4
	.3173	-15.24	-102.1	-15.87	-197.3	-31.12	-299.4	-3.025	-197.6
	.6582	-15.72	-87.66	-5.862	-175.4	-21.58	-262.4	-2.998	-197.3
8.007	.1542	-14.72	-110.4	-23.22	-335.3	-37.95	-85.86	-3.260	-197.7
	.3320	-15.04	-101.2	-20.00	-195.8	-35.04	-297.0	-3.165	-198.6
	.6689	-16.02	-89.30	-7.043	-174.8	-23.06	-264.1	-3.108	-197.8
8.468	.1767	-15.72	-114.5	-23.80	-264.4	-39.13	-19.03	-3.179	-198.5
	.3300	-15.90	-105.8	-17.74	-175.3	-33.65	-281.1	-3.232	-198.1
	.6660	-16.06	-91.03	-11.04	-178.6	-27.10	-269.7	-3.183	-199.4
8.953	.1718	-15.96	-113.0	-22.92	-327.9	-38.89	-80.93	-3.422	-200.1
	.3261	-15.80	-108.7	-20.66	-204.2	-36.46	-312.9	-3.283	-200.3
	.6767	-16.53	-92.44	-11.95	-177.7	-28.49	-270.2	-3.227	-200.6
9.562	.1669	-16.36	-118.5	-22.27	-70.71	-38.64	-189.2	-3.572	-199.1
	.3291	-16.20	-114.1	-22.27	-174.1	-38.48	-288.3	-3.487	-201.4
	.6679	-17.01	-95.04	-15.03	-180.2	-32.05	-275.2	-3.335	-202.7
10.25	.1699	-18.79	-123.1	-20.00	-185.7	-38.79	-308.8	-3.387	-199.5
	.3320	-17.16	-109.2	-23.89	-249.6	-41.06	-358.8	-3.479	-204.2
	.6640	-17.24	-102.0	-16.44	-178.7	-33.68	-280.8	-3.602	-203.0
12.18	.1777	-18.30	-126.5	-20.82	-56.95	-39.13	-183.4	-4.095	-203.3
	.3378	-19.13	-120.2	-25.57	-211.1	-44.71	-331.4	-4.029	-206.5
	.6894	-18.65	-108.4	-28.73	-163.9	-47.38	-272.3	-3.845	-206.7
15.09	.1669	-21.68	-134.9	-22.92	-341.5	-44.60	-116.5	-4.787	-208.5
	.3300	-20.13	-123.3	-30.37	-222.0	-50.50	-345.4	-4.915	-211.4
	.6611	-20.68	-117.3	-35.84	-133.4	-56.53	-250.8	-4.932	-212.2
20.25	.1748	-25.82	-152.8	-19.08	-135.0	-44.91	-287.8	-6.044	-211.1
	.3232	-23.41	-130.3	39.37	-8.429	15.96	-138.7	-6.308	-215.6
	.6572	-23.16	-125.6	-33.25	-94.89	-56.41	-220.5	-6.145	-217.2

11:01 A.M.

TABLE 4-9. POST-ROOM-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

APR. 30, 1965 3:29 P.M. RUN 17059 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.5041	.1738	10.30 -198.8	4.943 -5.886	15.24 -204.7	-3.619 -177.6
	.3378	10.52 -197.1	5.318 -4.132	15.84 -201.2	-3.403 -179.2
	.6689	11.10 -196.0	5.041 -1.566	16.14 -197.5	-3.381 -180.2
1.010	.1718	9.912 -208.6	6.790 -7.332	16.70 -215.9	-3.845 -180.4
	.3320	10.56 -207.7	5.831 -1.714	16.39 -209.5	-3.537 -180.4
	.6767	10.74 -206.8	5.454 -1.277	16.22 -208.1	-3.425 -180.6
1.480	.1796	8.889 -220.7	7.420 -6.984	16.30 -227.7	-3.037 -181.6
	.3330	9.584 -220.2	6.611 -5.968	16.19 -226.1	-3.462 -180.0
	.6787	10.12 -218.1	5.981 -1.156	16.10 -219.2	-3.151 -180.8
1.968	.1630	8.073 -233.3	8.625 -6.140	16.69 -239.5	-3.574 -181.0
	.3154	9.043 -227.6	7.487 -4.054	16.53 -231.6	-3.708 -182.5
	.6943	9.638 -227.7	6.442 -2.648	16.08 -230.4	-3.535 -181.0
2.468	.1816	7.557 -241.9	9.411 -5.300	16.96 -247.2	-3.237 -181.1
	.3154	8.374 -239.2	8.077 -3.746	16.45 -242.9	-3.276 -181.3
	.6756	8.935 -237.7	7.241 -2.003	16.17 -239.7	-3.326 -181.1
3.445	.1611	6.330 -262.4	12.15 -5.656	18.48 -268.1	-3.326 -181.6
	.3154	7.432 -259.3	10.12 -2.511	17.55 -261.8	-3.387 -181.7
	.6777	7.751 -260.8	9.058 -1.718	16.81 -262.5	-3.311 -181.3
3.921	.1621	5.993 -282 9	13.75 -6.003	19.75 -288.9	-3.273 -182.3
	.3320	6.600 -277.0	11.62 -3.285	18.22 -280.3	-3.332 -181.5
	.6513	7.292 -276.9	10.47 -2.144	17.77 -279.0	-3.186 -182.2
4.125	.1542	5.740 -286.8	14.64 -5.660	20.38 -292.4	-3.520 -182.2
	.3330	6.670 -282.9	12.20 -3.210	18.88 -286.1	-3.513 -181.6
	.6816	6.772 -283.2	11.13 -2.507	17.90 -285.7	-3.195 -180.8
4.398	.1748	5.418 -298.1	15.04 -5.703	20.46 -303.8	-3.635 -180.5
	.3320	6.345 -290.5	12.93 -3.382	19.28 -293.9	-3.332 -182.1
	.6914	5.996 -291.0	11.90 -3.218	17.89 -294.2	-3.318 -182.1
4.539	.1826	3.841 -306.8	16.38 -7.265	20.22 -314.0	-3.382 -183.7
	.3125	5.239 -302.4	14.23 -4.238	19.47 -306.6	-3.540 -181.8
	.6728	5.547 -300.1	12.84 -3.375	18.38 -303.5	-3.540 -182.5
4.781	.1591	1.376 -323.8	18.85 -10.12	20.23 -334.0	-3.066 -182.2
	.3144	3.786 -311.5	15.52 -5.804	19.30 -317.3	-3.096 -184.2
	.6855	4.261 -310.3	13.99 -4.656	18.25 -315.0	-3.316 -181.8
4.984	.1845	-1.611 -337.4	21.00 -10.51	19.39 -346.9	-3.226 -183.8
	.3173	1.823 -326.7	17.47 -6.921	19.29 -333.6	-3.276 -182.0
	.6542	2.729 -319.5	15.52 -6.394	18.25 -325.9	-3.244 -183.3
5.101	.1611	-12.09 -329.5	29.91 -52.60	17.82 -22.16	-3.181 -182.3
	.3085	-1.050 -338.7	19.91 -8.937	18.86 -347.7	-3.483 -181.5
	.6757	.5112 -329.1	17.42 -8.964	17.93 -338.0	-3.304 -181.0
5.320	.1542	-9.822 -244.4	25.46 -160.7	15.64 -45.22	-3.557 -181.8
	.3330	-4.874 -346.9	22.90 -14.14	18.02 -1.105	-3.332 -181.6
	.6738	-2.514 -337.9	19.86 -12.50	17.35 -350.4	-3.395 -183.4
5.539	.1826	-5.701 -247.2	18.78 -169.8	13.07 -57.06	-3.287 -183.5
	.3437	-13.31 -348.9	30.23 -29.80	16.91 -18.78	-3.288 -183.0
	.6542	-7.170 -340.9	23.49 -22.37	16.32 -3.277	-3.386 -182.5
5.718	.1582	-1.145 -260.6	6.292 -176.3	5.147 -77.02	-3.837 -179.6
	.3417	-13.61 -254.8	28.55 -137.9	14.93 -32.78	-3.520 -181.4
	.6630	-13.39 -328.0	28.87 -47.08	15.47 -15.15	-3.504 -182.4
5.890	.1611	-1.304 -259.5	2.107 -182.0	.8032 -81.58	-3.780 -184.1
	.3291	-8.142 -237.0	20.74 -169.1	12.60 -46.12	-3.409 -184.3
	.6386	-15.16 -258.2	29.30 -129.0	14.13 -27.24	-3.481 -182.2
6.101	.1533	-.8725 -261.6	-.7666 -178.0	-1.639 -79.70	-3.613 -182.3
	.3398	-5.799 -241.2	17.10 -172.7	11.30 -54.01	-3.291 -181.9
	.6650	-10.92 -237.2	23.49 -157.9	12.57 -35.21	-3.204 -182.6
6.281	.1640	-1.101 -266.0	-2.981 -181.2	-4.083 -87.33	-2.988 -182.6
	.3261	-3.907 -245.5	12.56 -176.1	8.657 -61.75	-3.435 -181.8
	.6835	-7.822 -231.9	19.04 -170.2	11.22 -42.20	-3.426 -183.3

TABLE 4-9. POST-ROOM-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 3 (Continued)

APR. 30, 1965 3:29 P.M. RUN 17059 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.531	.1601	-1.250 -270.6	-4.155 -165.7	-5.406 -76.34	-3.557 -179.7
	.3242	-3.123 -253.9	9.715 -175.1	6.591 -69.05	-3.155 -183.0
	.6787	-5.859 -238.5	15.59 -171.0	9.731 -49.66	-3.288 -181.9
6.789	.1582	-1.778 -267.6	-8.260 -179:5	-10.03 -87.17	-3.194 -184.7
	.3300	-2.629 -256.2	8.006 -176.0	5.376 -72.31	-3.494 -183.8
	.6787	-4.708 -239.9	13.20 -174.1	8.496 -54.11	-3.365 -182.9
6.945	.1591	-1.508 -271.9	-9.865 -166.2	-11.37 -78.23	-3.396 -182.0
	.3222	-2.419 -261.0	5.330 -175.7	2.911 -76.86	-3.442 -181.7
	.6748	-4.095 -245.8	11.01 -176.9	6.917 -62.81	-3.398 -183.0
7.156	.1630	-1.977 -273.3	-13.84 -194.1	-15.82 -107.4	-3.574 -183.6
	.3183	-2.305 -262 0	3.682 -177.5	1.376 -79.55	-3.540 -182.4
	.6806	-3.635 -246.7	9.055 -176.9	5.419 -63.72	-3.387 -183.4
7.281	.1640	-2.227 -273.3	-7.630 -191.8	-9.858 -105.2	-3.024 -183.2
	.3271	-2.551 -263.9	2.097 -176.3	-.4541 -80.30	-3.167 -182.8
	.6728	-3.187 -251.5	7.601 -176.6	4.414 -68.21	-3.295 -183.0
7.476	.1816	-2.043 -273.9	-12.71 -150.5	-14.76 -64.45	-3.074 -182.4
	.3134	-2.571 -265.6	.7675 -178.7	-1.804 -84.35	-3.665 -182.2
	.6777	-3.105 -253.4	6.163 -177.0	3.057 -70.45	-3.360 -183.6
7.742	.1669	-2.933 -273.6	-11.62 -158.1	-14.55 -71.85	-3.157 -185.0
	.3242	-2.542 -266.7	-.9262 -179.9	-3.469 -86.74	-3.354 -184.3
	.6699	-2.773 -255.7	4.639 -177.5	1.866 -73.30	-3.401 -183.4
7.945	.1787	-2.325 -275.8	-16.47 -153.4	-18.80 -69.31	-3.601 -182.8
	.3378	-2.490 -269.0	-1.617 -177.9	-4.107 -86.98	-3.274 -182.8
	.6826	-2.798 -258.0	3.641 -178.9	.8422 -77.06	-3.306 -184.0
8.468	.1621	-2.964 -277.2	-19.85 -194.4	-22.81 -111.6	-3.128 -185.1
	.3222	-2.702 -272.2	-5.914 -177.8	-8.616 -90.06	-3.388 -182.8
	.6699	-2.790 -263.8	.7529 -176.4	-2.037 -80.37	-3.316 -183.5
9.187	.1582	-3.283 -278.8	-28.86 -221.4	-32.14 -140.3	-3.592 -185.4
	.3427	-2.993 -274.7	-6.233 -181.5	-9.227 -96.25	-3.471 -184.5
	.6660	-2.858 -265.9	-1.431 -178.3	-4.331 -84.30	-3.367 -184.2
9.593	.1582	-4.727 -279.0	-25.48 -141.0	-30.21 -60.03	-3.304 -185.3
	.3349	-3.753 -273.7	-8.544 -183.5	-12.29 -97.29	-3.333 -184.6
	.6835	-3.760 -272.1	-3.108 -177.1	-6.870 -89.37	-3.332 -183.7
10.03	.1621	-4.738 -283.2	-27.60 -243.5	-32.36 -166.7	-3.486 -184.6
	.3242	-4.077 -279.9	-14.06 -184.6	-18.14 -104.5	-3.300 -184.1
	.6757	-3.914 -273.6	-5.767 -176.6	-9.682 -90.27	-3.287 -184.3
12.28	.1591	-6.689 -290.8	-37.50 -225.2	-44.19 -156.0	-3.486 -185.8
	.3193	-6.155 -275.8	7.805 -270.9	1.648 -186.8	-3.276 -185.0
	.6601	-5.616 -282.1	-12.65 -176.0	-18.27 -98.23	-3.382 -185.0
15.09	.1621	-8.786 -296.2	-29.54 -136.3	-38.33 -72.67	-3.326 -186.5
	.3242	-7.673 -296.0	-20.39 -115.0	-28.06 -51.14	-3.477 -186.2
	.6738	-7.422 -292.5	-22.04 -164.1	-29.46 -96.75	-3.367 -186.4
19.76	.1826	-11.67 -305.7	-33.62 -99.01	-45.29 -44.76	-3.362 -188.7
	.3154	-10.77 -305.6	-29.73 -177.9	-40.50 -123.5	-3.428 -188.8
	.6806	-10.49 -304.1	-30.67 -162.1	-41.16 -106.3	-3.428 -188.7

4:29 P.M.

TABLE 4-10. POST-ROOM-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 4

MAY 1, 1965 10:09 A.M. RUN 17060 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.5109	.1552	10.79 -195.3	3.745 -8.921	14.53 -204.2	-3.790 -179.2
	.6679	10.69 -193.6	5.347 -1.695	16.04 -195.2	-3.184 -181.7
.9921	.1669	9.775 -209.6	6.004 -6.507	15.77 -216.1	-2.980 -178.7
	.3203	10.17 -206.5	5.998 -1.851	16.17 -208.4	-3.503 -179.3
	.6884	10.24 -204.1	5.717 -1.113	15.96 -205.2	-3.284 -181.2
1.480	.1591	9.290 -216.3	6.748 -7.320	16.03 -223.7	-3.213 -180.6
	.3173	9.523 -215.4	6.270 -2.808	15.79 -218.2	-3.295 -181.0
	.6601	9.938 -214.8	6.050 -1.234	15.98 -216.0	-3.243 -180.9
1.964	.1591	8.505 -226.3	7.846 -6.523	16.35 -232.9	-3.609 -181.0
	.3173	8.923 -224.6	6.992 -3.937	15.91 -228.5	-3.386 -181.1
	.6582	9.439 -224.2	6.463 -2.355	15.90 -226.5	-3.339 -180.9
2.468	.1591	7.947 -235.7	8.862 -7.437	16.81 -243.1	-3.323 -180.0
	.3144	8.450 -233.2	7.705 -3.640	16.15 -236.9	-3.413 -181.4
	.6777	8.857 -233.3	7.163 -2.757	16.02 -236.1	-3.335 -181.0
3.445	.1582	7.032 -253.0	11.21 -5.597	18.24 -258.6	-3.304 -180.8
	.3339	7.867 -250.1	9.584 -2.808	17.45 -252.9	-3.418 -181.1
	.6748	8.020 -252.4	8.946 -2.046	16.96 -254.5	-3.321 -181.4
4.000	.1757	7.171 -261.9	12.21 -5.738	19.39 -267.6	-3.392 -180.9
	.3437	7.344 -263.7	10.98 -3.472	18.32 -267.2	-3.372 -181.9
	.6552	7.449 -265.3	10.33 -2.074	17.78 -267.4	-3.560 -181.5
4.148	.1591	7.001 -271.3	13.27 -5.371	20.27 -276.6	-3.323 -181.8
	.3203	7.275 -269.6	11.71 -3.980	18.99 -273.5	-3.050 -180.2
	.6562	7.305 -272.4	10.97 -2.710	18.28 -275.1	-3.326 -181.8
4.320	.1562	7.187 -275.8	14.13 -6.527	21.32 -282.4	-4.013 -182.6
	.3437	7.408 -275.1	12.33 -3.394	19.74 -278.5	-3.701 -182.8
	.6708	7.136 -280.9	11.71 -2.914	18.85 -283.8	-3.325 -181.8
4.578	.1582	6.617 -286.2	15.13 -6.832	21.75 -293.1	-3.450 -182.0
	.3466	6.936 -286.7	13.23 -4.007	20.16 -290.7	-3.562 -180.1
	.6718	6.572 -288.2	12.50 -3.585	19.07 -291.8	-3.440 -182.7
4.757	.1611	5.561 -298.7	16.41 -7.296	21.97 -306.0	-3.848 -186.0
	.3281	6.187 -299.0	14.42 -5.101	20.60 -304.1	-3.303 -179.7
	.6572	5.838 -299.1	13.57 -4.687	19.41 -303.8	-3.352 -181.3
4.929	.1826	4.106 -316.5	17.80 -8.648	21.90 -325.1	-3.094 -182.5
	.3242	4.664 -311.4	15.83 -6.628	20.50 -318.0	-3.345 -182.6
	.6445	4.821 -309.2	14.83 -6.117	19.65 -315.3	-3.420 -183.3
5.148	.1757	.4233 -333.8	20.98 -12.39	21.41 -346.2	-3.489 -180.6
	.3339	2.890 -324.0	17.57 -8.175	20.46 -332.2	-3.471 -181.6
	.6738	2.817 -320.2	16.45 -8.714	19.27 -329.0	-3.415 -183.1
5.312	.1845	-6.940 -346.7	26.73 -24.12	19.79 -10.85	-3.226 -182.9
	.3173	-1.141 -339.3	20.93 -12.48	19.79 -351.8	-3.259 -180.7
	.6552	.0903 -331.3	18.71 -12.23	18.80 -343.5	-3.399 -181.6
5.531	.1621	-9.916 -242.7	26.61 -164.0	16.69 -46.76	-3.693 -185.7
	.3281	-8.315 -348.5	26.84 -21.11	18.53 -9.707	-3.400 -182.3
	.6562	-4.256 -338.7	22.21 -19.10	17.95 -357.8	-3.395 -182.9
5.703	.1630	-3.016 -255.5	11.81 -175.0	8.801 -70.59	-3.293 -181.7
	.3222	-22.07 -292.1	39.17 -95.00	17.10 -27.19	-3.398 -182.1
	.6699	-10.47 -335.0	27.39 -35.12	16.91 -10.19	-3.425 -182.5
5.914	.1826	-3.024 -256.7	11.46 -173.1	8.437 -69.98	-3.222 -183.0
	.3154	-11.09 -240.5	26.00 -162.2	14.90 -42.82	-3.239 -182.1
	.6894	-16.45 -282.2	31.95 -100.1	15.49 -22.39	-3.327 -182.7
6.179	.1787	-1.961 -254.7	6.596 -177.7	4.634 -72.53	-3.506 -173.1
	.3408	-7.105 -240.4	19.87 -170.6	12.76 -51.15	-3.243 -183.2
	.6523	-11.77 -240.2	25.89 -152.8	14.12 -33.11	-3.359 -183.3
6.343	.1630	-1.911 -262.0	-1.179 -174.0	-3.090 -76.13	-3.364 -183.8
	.3173	-4.131 -246.4	14.40 -174.7	10.27 -61.26	-3.493 -181.7
	.6601	-8.088 -233.9	20.72 -166.4	12.63 -40.44	-3.370 -182.8

TABLE 4-10. POST-ROOM-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 4 (Continued)

MAY 1, 1965 10:09 A.M. RUN 17060 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.492	.1640	-1.708 -263.3	-.9995 -176.2	-2.708 -79.57	-3.452 -184.6
	.3281	-2.896 -251.9	10.57 -175.8	7.679 -67.79	-3.249 -181.7
	.6464	-5.120 -238.1	15.85 -171.4	10.73 -49.63	-3.425 -182.5
6.703	.1591	-1.259 -264.4	-5.959 -159.3	-7.219 -63.77	-3.784 -183.3
	.3251	-2.386 -254.6	8.128 -176.3	5.742 -70.93	-3.425 -182.6
	.6777	-4.267 -239.5	13.49 -174.5	9.231 -54.10	-3.399 -183.5
6.960	.1787	-1.727 -260.9	-4.058 -178.6	-5.786 -79.65	-3.249 -184.7
	.3349	-1.861 -254.5	6.523 -177.2	4.661 -71.74	-3.437 -182.9
	.6875	-3.540 -242.7	11.31 -175.1	7.779 -57.85	-3.270 -183.3
7.101	.1611	-1.743 -265.0	-9.541 -145.1	-11.28 -50.20	-3.677 -183.9
	.3212	-1.625 -260.6	4.138 -176.3	2.512 -77.01	-3.450 -182.4
	.6787	-2.903 -247.5	9.048 -176.9	6.145 -64.44	-3.408 -182.8
7.304	.1621	-1.860 -268.4	-11.66 -223.9	-13.52 -132.4	-3.201 -182.9
	.3261	-1.692 -262.1	2.026 -180.0	.3330 -82.21	-3.266 -183.5
	.6738	-2.514 -250.7	7.441 -176.6	4.926 -67.43	-3.326 -183.5
7.476	.1796	-2.436 -266.8	-5.358 -192.8	-7.795 -99.78	-3.522 -183.8
	.3359	-1.762 -262.3	1.557 -178.8	-.2050 -81.25	-3.359 -182.8
	.6787	-2.412 -252.8	6.071 -176.6	3.659 -69.46	-3.382 -183.4
7.710	.1806	-2.237 -269.9	-18.00 -172.0	-20.23 -81.98	-3.154 -182.5
	.3388	-1.777 -264.8	.3916 -175.6	-1.385 -80.49	-3.266 -182.7
	.6748	-2.212 -255.5	4.724 -176.9	2.510 -72.50	-3.312 -183.7
8.125	.1582	-2.605 -270.3	-12.33 -128.3	-14.94 -38.64	-3.082 -183.4
	.3291	-1.459 -262.8	-1.425 -182.4	-2.885 -85.33	-3.383 -184.3
	.6923	-2.651 -257.2	3.404 -177.2	.7529 -74.41	-3.260 -183.5
8.593	.1767	-3.008 -268.4	-10.10 -180.6	-13.11 -89.17	-3.570 -183.2
	.3369	-2.364 -269.9	-3.357 -183.8	-5.722 -93.84	-3.505 -183.8
	.6728	-2.220 -260.2	.5527 -177.5	-1.667 -77.74	-3.338 -183.9
9.031	.1572	-3.796 -274.2	-8.743 -166.1	-12.54 -80.42	-3.210 -186.6
	.3427	-2.993 -268.4	-5.950 -184.3	-8.943 -92.88	-3.471 -184.2
	.6611	-2.675 -268.2	-1.978 -177.3	-4.654 -85.58	-3.404 -184.2
9.406	.1562	-3.911 -274.9	-23.27 -194.8	-27.18 -109.7	-3.521 -183.7
	.3398	-3.130 -272.9	-6.313 -182.0	-9.444 -94.92	-3.291 -183.8
	.6591	-2.850 -269.3	-4.270 -178.8	-7.121 -88.26	-3.417 -184.2
10.12	.1621	-4.758 -278.4	-39.64 -335.7	-44.40 -254.1	-3.591 -184.4
	.3291	-3.757 -274.9	-13.14 -186.5	-16.90 -101.4	-3.383 -183.4
	.6503	-3.081 -272.9	-6.945 -180.5	-10.02 -93.55	-3.313 -184.3
12.00	.1787	-6.924 -279.3	-32.25 -219.2	-39.18 -138.5	-3.264 -183.5
	.3378	-5.673 -277.7	-29.49 -162.2	-35.16 -79.94	-3.300 -184.4
	.6533	-4.656 -274.0	-13.41 -178.5	-18.07 -92.54	-3.296 -185.0
15.14	.1621	-9.082 -290.2	-23.22 -1.375	-32.30 -291.6	-3.574 -186.2
	.3251	-7.510 -290.1	-17.75 -216.4	-25.26 -146.6	-3.344 -186.3
	.6748	-6.773 -288.7	-24.36 -194.9	-31.13 -123.7	-3.381 -186.5
19.82	.1533	-11.13 -296.2	-15.76 -213.6	-26.90 -149.9	-3.650 -187.7
	.3359	-10.43 -301.8	-30.62 -270.6	-41.06 -212.4	-3.427 -188.2
	.6679	-9.594 -298.2	-22.35 -281.9	-31.95 -220.1	-3.430 -188.4
.5058	.1777	10.57 -194.6	3.912 -8.425	14.48 -203.0	-3.680 -177.6
	.3447	10.35 -194.8	5.283 -4.312	15.63 -199.2	-3.162 -181.0
	.6621	10.70 -194.2	5.445 -1.792	16.15 -196.0	-3.217 -180.5

11:15 A.M.

TABLE 4-11. POST-HIGH-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

DEC. 22, 1965 9:51 A.M. RUN 17396 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5078	.1699	14.62 -198.7	-.2636 -187.8	14.35 -26.55	-3.521 -177.7
	.3222	15.43 -195.5	.2978 -183.9	15.73 -19.53	-3.379 -180.3
	.6806	15.21 -193.7	.6958 -182.3	15.91 -16.15	-3.255 -180.2
1.003	.1699	15.21 -207.4	1.440 -191.7	16.65 -39.25	-3.686 -177.5
	.3320	15.10 -206.6	.2783 -179.6	15.38 -26.32	-3.120 -180.7
	.6386	14.71 -206.8	1.326 -181.6	16.03 -28.56	-3.352 -181.2
1.488	.1767	14.08 -219.8	2.397 -185.6	16.48 -45.49	-3.311 -179.5
	.3339	14.23 -217.1	1.707 -182.4	15.94 -39.56	-3.333 -181.1
	.6640	14.34 -217.4	1.098 -181.9	15.43 -39.44	-3.376 -180.3
1.980	.1582	11.74 -227.0	5.192 -184.7	16.93 -51.80	-3.304 -181.6
	.3339	13.28 -227.6	2.756 -181.7	16.03 -49.42	-3.384 -180.5
	.6669	13.82 -226.4	1.791 -181.7	15.61 -48.25	-3.379 -180.6
2.484	.1767	11.34 -234.6	5.695 -185.9	17.03 -60.64	-3.344 -181.3
	.3310	12.73 -234.3	3.552 -182.6	16.28 -56.97	-3.427 -181.2
	.6630	12.70 -234.2	1.949 -180.5	14.65 -54.80	-3.388 -181.0
3.464	.1708	9.135 -243.8	9.904 -190.3	19.04 -74.16	-3.437 -181.8
	.3242	11.06 -244.8	6.414 -184.6	17.48 -69.49	-3.398 -181.7
	.6748	11.91 -245.3	4.375 -182.7	16.29 -68.09	-3.348 -181.5
4.015	.1708	10.75 -249.5	10.77 -180.4	21.53 -68.92	-3.537 -180.1
	.3232	10.09 -253.9	8.310 -202.1	18.40 -96.08	-3.372 -182.7
	.6669	11.75 -251.5	5.966 -181.0	17.72 -72.67	-3.345 -181.2
4.171	.1777	10.94 -254.3	12.15 -194.2	23.10 -88.62	-3.554 -183.1
	.3359	9.832 -248.1	8.225 -180.8	18.05 -68.98	-3.387 -182.6
	.6650	11.82 -255.5	6.469 -185.6	18.29 -81.17	-3.410 -181.5
4.390	.1708	9.914 -262.9	13.07 -203.8	22.99 -116.7	-3.404 -183.7
	.3271	10.16 -252.9	10.31 -179.2	20.47 -72.19	-3.230 -181.6
	.6689	11.86 -260.2	7.234 -184.0	19.09 -84.30	-3.367 -182.3
4.617	.1796	8.682 -254.3	12.80 -195.9	21.48 -90.25	-3.299 -183.6
	.3291	11.25 -262.0	10.79 -187.3	22.04 -89.38	-3.460 -181.2
	.6728	11.36 -264.5	8.538 -188.7	19.90 -93.28	-3.395 -182.3
4.804	.1689	10.83 -261.9	13.50 -181.4	24.33 -83.35	-3.671 -181.5
	.3486	10.56 -267.5	11.20 -190.4	21.77 -98.07	-3.413 -181.2
	.6826	10.90 -277.9	9.676 -196.4	20.58 -114.3	-3.320 -182.3
4.953	.1738	13.50 -279.4	13.78 -188.1	27.29 -107.5	-3.325 -183.8
	.3242	11.19 -278.4	12.50 -193.0	23.69 -111.5	-3.381 -181.2
	.6787	9.255 -288.9	11.51 -212.0	20.77 -140.9	-3.301 -182.3
5.171	.1767	11.26 -315.7	16.80 -204.8	28.06 -160.5	-3.377 -180.5
	.3378	10.50 -298.5	14.15 -203.3	24.66 -141.8	-3.266 -182.0
	.6718	7.256 -295.8	13.44 -226.2	20.70 -162.1	-3.381 -182.6
5.382	.1777	4.875 -260.3	-2.187 -341.7	2.687 -242.1	-3.264 -183.2
	.3281	9.235 -314.7	15.41 -220.7	24.65 -175.5	-3.400 -181.7
	.6699	5.362 -299.1	14.63 -243.2	20.00 -182.4	-3.381 -182.5
5.570	.1708	4.965 -256.2	-18.46 -343.4	-13.49 -239.7	-3.471 -183.8
	.3251	3.147 -330.5	20.41 -238.8	23.56 -209.4	-3.433 -181.7
	.6796	3.580 -294.4	15.43 -266.5	19.01 -200.9	-3.379 -182.0
5.734	.1708	-1.694 -257.0	-2.339 -23.20	-4.034 -280.2	-3.471 -181.3
	.3164	-.1342 -280.7	21.34 -319.0	21.20 -239.0	-3.504 -182.5
	.6933	2.820 -279.9	15.18 -295.3	18.00 -215.3	-3.335 -182.2
5.968	.1728	5.411 -261.9	-11.98 -359.8	-6.577 -261.8	-3.239 -181.6
	.3251	3.736 -262.7	8.706 -.0781	12.44 -262.7	-3.266 -182.6
	.6748	3.108 -265.2	13.59 -324.6	16.70 -229.9	-3.343 -182.9
6.179	.1718	1.899 -253.0	-10.55 -348.8	-8.652 -241.9	-3.355 -181.3
	.3242	2.543 -263.5	11.33 -354.8	13.87 -258.4	-3.416 -183.3
	.6718	4.632 -260.8	10.65 -341.6	15.29 -242.5	-3.330 -182.3
6.392	.1689	5.066 -264.1	-19.72 -347.1	-14.65 -251.2	-3.572 -182.4
	.3476	5.308 -264.2	-3.410 -33.52	1.897 -297.7	-3.273 -182.4
	.6728	4.941 -260.4	8.205 -351.6	13.14 -252.1	-3.377 -182.3

TABLE 4-11. POST-HIGH-TEMPERATURE VIBRATION FREQUENCY RESPONSE, TEST SPECIMEN NO. 3 (Continued)

DEC. 22, 1965 9:51 A.M. RUN 17396 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
6.601	.1708	-.8872 -263.8	-23.97 -199.1	-24.86 -1[illegible]	-3.504 -183.6
	.3251	2.956 -261.7	4.986 -20.67	7.942 -282.4	-3.248 -182.6
	.6669	4.930 -263.4	5.236 -353.1	10.16 -256.5	-3.315 -182.9
6.867	.1767	5.678 -256.1	-25.25 -29.78	-19.57 -285.9	-3.474 -183.7
	.3339	3.077 -263.6	.3857 -323.2	3.462 -226.9	-3.428 -183.2
	.6689	4.756 -264.2	4.119 -351.2	8.876 -255.5	-3.396 -183.[illegible]
7.015	.1728	-.5053 -27[illegible].2	-27.55 -65.38	-28.05 -335.6	-3.406 -184.2
	.3203	4.062 -259.9	.1806 -33.96	4.243 -293.8	-3.446 -182.8
	.6738	4.738 -263.3	2.026 -11.04	6.765 -274.4	-3.369 -183.2
7.171	.1679	2.019 -277.2	-19.12 -279.3	-17.10 -196.5	-3.522 -182.9
	.3457	6.044 -260.4	-19.27 -115.8	-13.22 -16.38	-3.447 -183.1
	.6660	5.755 -266.7	-3.157 -355.5	2.597 -262.2	-3.340 -183.3
7.367	.1796	1.976 -286.2	-17.72 -33.92	-15.75 -320.1	-3.489 -182.6
	.3388	4.072 -265.[illegible]	-2.225 -5.921	1.846 -27[illegible].9	-3.317 -183.5
	.6767	4.301 -264.4	1.346 -8.468	5.647 -272.9	-3.372 -182.8
7.562	.1777	2.071 -294.9	-20.63 -13.59	-17.96 -3[illegible]8.5	-3.522 -182.[illegible]
	.3330	5.694 -269.6	-20.76 -269.5	-15.06 -179.2	-3.313 -183.3
	.6689	6.586 -269.4	-10.30 -18.17	-3.721 -287.6	-3.405 -183.2
7.789	.1562	1.446 -285.9	-28.62 -115.3	-27.18 -41.26	-3.375 -182.7
	.3339	3.912 -271.3	-7.408 -335.6	-3.496 -246.9	-3.410 -183.5
	.6669	3.499 -271.9	-1.492 -344.5	2.006 -256.5	-3.345 -183.2
7.976	.1718	2.510 -29[illegible].8	-35.37 -97.26	-32.86 -28.13	-3.455 -184.1
	.3251	3.930 -271.1	-15.26 -85.12	-11.33 -356.2	-3.309 -183.3
	.6718	4.257 -27[illegible].2	-1.851 -20.48	2.405 -290.6	-3.342 -183.2
8.492	.1767	-3.426 -294.3	-20.89 -1[illegible].2	-24.32 -34.62	-3.311 -182.9
	.3339	4.136 -280.4	-13.13 -187.2	-9.000 -1[illegible]7.7	-3.376 -183.2
	.6650	4.711 -268.4	-4.349 -39.87	.3623 -308.3	-3.344 -183.4
9.156	.1757	2.888 -286.5	-41.97 -325.2	-39.08 -251.8	-3.326 -184.6
	.3300	3.196 -290.3	-19.94 -266.1	-16.75 -196.5	-3.409 -183.3
	.6630	3.559 -276.5	-4.607 -355.1	-1.048 -271.6	-3.405 -184.1
9.593	.1699	-2.465 -291.8	-14.74 -30[illegible].3	-17.20 -232.2	-3.318 -183.2
	.3281	1.518 -290.4	-7.513 -263.5	-5.994 -194.[illegible]	-3.443 -184.[illegible]
	.6572	2.107 -274.8	-9.116 -19.[illegible]2	-7.007 -293.8	-3.416 -184.1
10.28	.1708	-1.938 -296.2	-23.83 -316.8	-25.77 -255.1	-3.371 -184.1
	.3212	1.208 -282.[illegible]	-33.46 -195.4	-32.25 -117.4	-3.378 -183.9
	.6640	3.042 -278.2	-7.377 -350.[illegible]	-4.334 -268.3	-3.378 -184.2
12.14	.1552	.0000 -294.4	-17.52 -239.9	-17.52 -174.4	-3.447 -185.8
	.3291	-2.718 -297.5	-14.91 -241.[illegible]	-17.63 -178.6	-3.443 -185.3
	.6572	1.789 -288.2	-9.354 -26[illegible].6	-7.564 -188.9	-3.413 -185.2
15.25	.1748	-8.230 -302.2	-7.834 -338.8	-16.06 -281.1	-3.357 -186.3
	.3291	-1.656 -299.8	-19.87 -345.1	-21.53 -284.9	-3.381 -186.3
	.6455	-1.988 -296.4	-37.43 -100.6	-39.42 -37.12	-3.365 -186.5
20.00	.1748	-11.84 -96.70	-33.06 -33.67	-44.91 -130.3	-3.455 -188.8
	.3291	-15.93 -326.3	-28.46 -129.2	-44.40 -95.57	-3.433 -188.6
	.6582	-4.367 -312.0	-42.52 -214.6	-46.88 -166.7	-3.438 -188.6

10:51 A.M.

TABLE 4-12. POST-MECHANICAL SHOCK FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

MAY 6, 1965 1:45 P.M. RUN 17063 FREQUENCY RESPONSE TEST

FREQ.	AMPL VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
.5058	.1630	9.948 +196.6	4.092 -15.68	14.04 -212.2	-3.187 -182.8
	.3212	10.21 +195.7	5.034 -7.816	15.25 -203.5	-3.317 -181.7
	.6689	10.81 +195.0	5.029 -3.398	15.84 -198.4	-3.251 -180.7
1.050	.1748	9.921 +208.5	5.793 -16.30	15.71 -224.8	-3.342 -178.8
	.3437	9.672 +209.1	5.664 -6.503	15.33 -215.6	-3.355 -181.6
	.6562	10.56 +206.0	5.458 -3.781	16.02 -209.8	-3.435 -180.6
1.476	.1572	9.341 +221.0	5.079 -12.26	14.42 -233.2	-3.357 -179.3
	.3398	9.500 +220.6	6.001 -7.503	15.50 -228.1	-3.471 -181.2
	.6562	10.03 +218.4	5.986 -3.484	16.02 -221.8	-3.223 -180.4
1.964	.1591	8.425 +232.6	7.093 -13.98	15.51 -246.6	-3.538 -179.5
	.3154	8.901 +229.2	6.778 -7.519	15.67 -236.7	-3.257 -181.0
	.6787	9.512 -227.8	6.272 -4.371	15.78 -232.2	-3.299 -180.7
2.468	.1572	7.947 +241.9	8.372 -10.66	16.32 -252.6	-3.431 -180.3
	.3378	8.503 +239.4	7.402 -6.042	15.90 -245.5	-3.370 -181.1
	.6787	8.[illegible] +237.7	6.961 -3.613	15.94 -241.3	-3.349 -180.9
3.441	.1816	7.259 +261.6	10.17 -7.863	17.43 -269.5	-3.269 -181.4
	.3183	7.510 +259.3	9.495 -5.398	17.00 -264.7	-3.306 -181.5
	.6552	7.815 +260.5	8.831 -3.316	16.64 -263.8	-3.352 -181.3
3.945	.1777	6.883 +277.8	11.91 -8.125	18.79 -285.9	-3.896 -178.7
	.3427	6.956 +277.5	11.11 -5.195	18.06 -282.7	-3.17[illegible] -180.5
	.6582	7.075 +275.6	10.19 -3.289	17.26 -278.9	-3.547 -182.0
4.117	.1806	6.387 +283.3	12.79 -8.632	19.17 -291.9	-3.187 -185.0
	.3339	6.923 +281.9	11.66 -5.414	18.59 -287.3	03.504 -183.1
	.6767	6.811 +281.9	10.83 -3.507	17.64 -285.4	-3.496 -180.9
4.367	.1572	6.021 +299.9	13.86 -8.687	19.88 -308.6	-3.321 -177.[illegible]
	.3320	6.455 +289.8	12.53 -5.828	18.98 -295.7	-3.417 -183.7
	.6845	6.106 +290.3	11.62 -4.093	17.73 -294.4	-3.479 -181.7
4.531	.1855	4.554 +310.0	14.96 -8.039	19.51 -318.0	-2.823 -180.3
	.3134	5.505 +301.5	13.70 -6.644	19.21 -308.2	-3.691 -181.3
	.6738	5.640 +299.2	12.53 -4.921	18.17 -304.1	-3.500 -182.6
4.796	.1738	3.225 +319.4	16.77 -11.11	20.00 -330.5	-3.811 -185.2
	.3476	4.194 +314.6	14.88 -6.875	19.07 -321.5	-3.018 -181.6
	.6523	4.731 +308.7	13.67 -5.582	18.40 -314.2	-3.252 -180.9
4.953	.1806	-.4819 -336.5	19.44 -12.82	18.95 -349.4	-3.083 -185.6
	.3408	2.380 -326.1	16.59 -8.304	18.97 -334.4	-3.122 -180.4
	.6562	2.863 -319.2	15.20 -7.152	18.07 -326.4	-3.465 -181.2
5.148	.1621	-10.08 -344.9	27.20 -37.95	17.12 -22.85	-2.793 -184.4
	.3203	-.7456 -338.6	19.12 -10.86	18.37 -349.5	-3.012 -181.4
	.6562	.6723 -329.0	17.03 -9.566	17.70 -338.6	-3.316 -183.0
5.382	.1630	-6.612 -247.6	19.79 -166.0	13.18 -53.76	-3.257 -186.7
	.3261	-5.564 -347.3	22.94 -17.97	17.37 -5.335	-3.149 -184.2
	.6699	-2.510 -338.0	19.66 -13.23	17.15 -351.2	-3.466 -181.7
5.515	.1875	-4.011 -248.1	15.19 -173.4	11.18 -61.60	-2.798 -183.8
	.3291	-14.56 -339.1	30.69 -43.28	16.13 -22.41	-3.215 -180.6
	.6552	-7.424 -344.5	23.71 -20.08	16.29 -4.671	-3.382 -183.3
5.710	.1660	.3500 -259.6	-4.371 -212.4	-4.020 -112.0	-2.737 -181.4
	.3291	-13.65 -246.6	27.81 -151.6	14.16 -38.32	-3.052 -181.4
	.6621	-14.40 -333.0	29.63 -43.24	15.23 -16.28	-3.273 -181.8
5.953	.1591	.2622 -267.1	-12.68 -224.7	-12.42 -131.8	-3.140 -179.2
	.3154	-6.209 -241.7	17.64 -169.7	11.43 -51.53	-3.440 -180.6
	.6777	-15.98 -261.7	29.58 -125.4	13.59 -27.19	-3.365 -182.0
6.085	.1650	.7382 -264.2	-28.39 -343.9	-27.65 -248.1	-2.863 -183.2
	.3242	-3.909 -246.6	12.88 -174.9	8.973 -61.59	-3.210 -183.8
	.6777	-11.18 -232.2	23.47 -164.8	12.29 -37.05	-3.445 -182.9
6.312	.1611	-.3759 -272.3	-22.39 -116.9	-22.76 -29.29	-2.996 -182.3
	.3203	-3.391 -246.7	9.937 -181.8	6.546 -68.59	-3.252 -183.9
	.6591	-7.598 -234.3	18.31 -170.2	10.71 -44.58	-3.392 -181.9

TABLE 4-12. POST-MECHANICAL SHOCK FREQUENCY RESPONSE, TEST SPECIMEN NO. 3 (Continued)

MAY 6, 1965 1:45 P.M. RUN 17063 FREQUENCY RESPONSE TEST

FREQ.	AMPL VOLTS (P-P)	PISTON POS./I	LOAD/PIST POS.	LOAD/I	I/VSIG
6.546	.1640	.2539 -267.8	-35.21 -17.69	-34.96 -285.5	-2.951 -183.2
	.3242	-2.124 -254.5	6.020 -186.8	3.896 -81.39	-3.416 -181.2
	.6728	-5.588 -236.8	14.47 -176.2	8.881 -53.08	-3.449 -183.0
6.750	.1582	-.2158 -269.8	-31.93 -199.6	-32.14 -109.5	-3.803 -182.1
	.3476	-1.756 -257.4	4.394 -185.2	2.637 -82.70	-3.230 -184.0
	.6767	-4.641 -242.7	11.69 -176.8	7.049 -59.55	-3.356 -183.3
6.937	.1621	.1035 -272.6	-38.48 -57.54	-38.38 -330.1	-3.309 -184.4
	.3242	-1.541 -262.7	1.514 -187.7	-.0268 -90.45	-3.362 -184.1
	.6435	-3.593 -246.1	9.147 -179.9	5.554 -66.12	-3.415 -182.7
7.101	.1416	-.6845 -270.8	-42.54 -24.93	-43.22 -295.8	-3.050 -182.3
	.3251	-1.604 -262.5	-.2563 -193.2	-1.860 -95.75	-3.416 -184.5
	.6816	-3.483 -248.5	7.451 -180.9	3.967 -69.47	-3.318 -182.6
7.328	.1601	-.7749 -273.8	-43.52 -224.1	-44.29 -137.9	-3.697 -182.3
	.3251	-1.604 -263.8	-2.457 -198.3	-4.061 -102.1	-3.416 -182.1
	.6738	-3.035 -251.4	5.830 -182.7	2.793 -74.17	-3.411 -183.5
7.500	.1611	-.6552 -273.4	-37.67 -268.7	-38.33 -182.2	-3.432 -181.6
	.3261	-1.789 -265.7	-5.195 -201.2	-6.984 -107.0	-3.530 -183.5
	.6767	-2.950 -254.2	4.221 -184.4	1.270 -78.73	-3.312 -183.2
7.718	.1806	-1.315 -275.1	-44.02 -88.72	-45.34 -3.863	-3.348 -184.7
	.3369	-1.633 -265.9	-5.691 -203.6	-7.325 -109.6	-3.334 -182.4
	.6777	-2.857 -254.9	2.806 -185.2	-.0512 -80.21	-3.411 -183.1
7.945	.1796	-.8935 -275.2	-32.36 -350.8	-33.25 -266.0	-3.522 -182.3
	.3408	-1.888 -268.1	-9.299 -208.2	-11.18 -116.3	-3.437 -182.8
	.6611	-2.833 -258.3	.8164 -183.4	-2.019 -81.77	-3.264 -183.1
8.468	.1630	-1.594 -275.3	23.36 -112.5	21.77 -27.85	-3.435 -185.3
	.3232	-1.938 -271.9	-27.60 -61.12	-29.54 -333.0	-3.450 -183.2
	.6708	-2.856 -262.8	-2.192 -189.0	-5.048 -91.83	-3.381 -183.4
9.062	.1601	-3.790 -275.5	3.790 -243.0	.0000 -158.5	-3.198 -184.3
	.3369	-2.298 -274.6	-29.34 -21.09	-31.64 -295.7	-3.488 -183.8
	.6621	-2.812 -266.4	-4.936 -194.1	-7.749 -100.6	-3.418 -184.2
9.468	.1611	-2.623 -281.7	24.49 -318.3	21.87 -240.0	-3.432 -183.0
	.3242	-2.542 -276.5	-35.81 -51.42	-38.35 -327.9	-3.228 -184.4
	.6748	-3.433 -270.4	-9.412 -201.0	-12.84 -111.5	-3.391 -184.1
10.15	.1367	-4.233 -285.6	-29.14 -149.8	-33.38 -75.42	-3.562 -184.1
	.3261	-3.328 -281.1	-31.55 -78.67	-34.88 -359.8	-3.391 -184.3
	.6787	-3.952 -273.7	-18.04 -203.7	-21.99 -117.5	-3.360 -184.2
12.26	.1816	-4.920 -289.4	-40.42 -171.4	-45.34 -100.8	-3.379 -185.2
	.3095	-5.306 -280.7	3.051 -210.7	-2.254 -131.5	-3.420 -185.4
	.6816	-5.393 -280.9	-15.87 -92.00	-21.26 -12.92	-3.335 -185.2
15.09	.1611	-6.567 -299.6	-31.70 -41.80	-38.27 -341.4	-3.450 -186.3
	.3242	-6.260 -293.1	-38.06 -262.7	-44.32 -195.9	-3.388 -186.5
	.6718	-6.625 -291.3	-27.77 -74.28	-34.39 -5.621	-3.393 -186.5
20.25	.1816	-8.857 -305.3	-24.34 -357.1	-33.20 -302.5	-3.410 -188.0
	.3134	-8.933 -303.4	-29.01 -300.6	-37.95 -244.1	-3.465 -188.1
	.6855	-9.466 -304.9	-37.76 -25.26	-47.23 -330.2	-3.445 -188.1

2:45 P.M.

TABLE 4-13. POST-THERMAL-VACUUM FREQUENCY RESPONSE, TEST SPECIMEN NO. 2

JUL. 27, 1965 9:15 A.M. RUN 17220 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.4980	.1992	5.979 -192.4	8.068 -9.949	14.04 -202.4	-7.681 -182.4
	.3203	6.508 -195.1	8.757 -5.148	15.26 -200.2	-7.661 -180.3
	.6640	6.719 -194..	8.945 -2.14.	15.66 -196.1	-7.684 -180.6
.9851	.1777	6.280 -206.9	9.472 -5.582	15.75 -212.5	-7.746 -182.2
	.3339	6.184 -203.1	9.361 -4.148	15.54 -207.2	-7.825 -180.4
	.6660	6.600 -204.1	9.267 -1.738	15.86 -205.8	-7.695 -180.7
1.472	.1777	5.479 -213.9	10.01 -10.74	15.49 -224.6	-7.629 -180.1
	.3271	5.662 -214.6	9.791 -6.941	15.45 -221.5	-7.732 -180.8
	.6650	6.077 -213.5	9.744 -2.347	15.82 -215.9	-7.739 -180.6
1.960	.1621	5.110 -226.3	10.87 -8.941	15.98 -235.2	-7.746 -180.3
	.3222	5.463 -224.2	10.45 -5.007	15.91 -229.2	-7.776 -181.1
	.6718	5.835 -222.5	10.11 -3.417	15.95 -225.9	-7.708 -181.6
2.457	.1630	4.794 -235.4	11.79 -7.308	16.59 -242.7	-7.630 -181.7
	.3232	5.049 -233.9	11.16 -4.753	16.21 -238.7	-7.686 -181.7
	.6689	5.485 -232.9	10.72 -3.050	16.20 -235.9	-7.725 -182.0
3.429	.1630	4.458 -255.1	14.05 -7.527	18.51 -262.6	-7.823 -183.8
	.3251	4.668 -255.1	13.09 -4.945	17.76 -260.0	-7.806 -183.6
	.6699	4.792 -255.8	12.48 -3.363	17.27 -259.2	-7.779 -183.6
3.937	.1689	4.213 -274.0	15.34 -8.875	19.55 -282.8	-8.128 -186.0
	.3330	4.008 -271.8	14.39 -5.042	18.40 -276.8	-7.942 -183.8
	.6630	4.111 -272.0	13.75 -3.378	17.86 -275.3	-7.827 -184.0
4.132	.1767	2.977 -284.0	16.36 -7.593	19.34 -291.6	-7.496 -186.4
	.3173	3.618 -281.8	15.23 -5.945	18.85 -287.7	-7.812 -183.1
	.6718	3.475 -282.0	14.44 -4.093	17.92 -286.0	-7.730 -184.6
4.312	.1738	2.845 -296.1	17.08 -10.30	19.92 -306.4	-8.190 -182.0
	.3330	3.077 -288.9	16.00 -5.878	19.07 -294.8	-8.135 -185.5
4.335	.6757	2.763 -289.2	15.19 -4.933	17.95 -294.1	-7.839 -184.3
4.515	.1621	.2060 -312.1	18.96 -9.593	19.17 -321.7	-7.507 -184.8
	.3154	1.748 -303.3	17.18 -6.75.	18.93 -310.1	-7.856 -184.5
	.6708	2.172 -299.8	16.06 -4.898	18.23 -304.7	-7.893 -185.1
4.750	.1621	-1.604 -322.8	20.58 -15.56	18.97 -338.4	-7.854 -182.7
	.3203	.3681 -312.5	18.33 -7.824	18.71 -320.3	-8.041 -186.5
4.710	.6748	1.054 -307.3	17.11 -5.824	18.17 -313.1	-8.178 -185.5
4.914	.1757	-5.371 -334.1	23.32 -21.26	17.95 -355.4	-8.016 -182.3
4.890	.3300	-1.604 -322.8	19.80 -10.46	18.20 -333.3	-7.937 -185.5
	.6650	-.5810 -319.0	18.46 -6.816	17.88 -325.8	-8.146 -186.2
5.109	.1650	-10.75 -335.6	27.34 -39.44	16.58 -15.08	-8.091 -182.0
	.3300	-4.300 -333.9	21.92 -12.94	17.62 -346.8	-8.409 -184.3
	.6708	-2.642 -328.5	20.04 -8.304	17.40 -336.8	-8.084 -185.3
5.343	.1796	-20.68 -268.8	35.88 -129.9	15.20 -28.77	-8.489 -184.0
	.3437	-8.454 -345.4	24.84 -14.96	16.38 -.4062	-8.221 -187.4
	.6513	-5.661 -336.3	22.31 -11.74	16.65 -348.1	-8.261 -185.4
5.515	.1757	-9.987 -237.6	21.74 -171.5	11.75 -49.23	-7.900 -182.4
	.1796	10.12 -182.3	-2.449 -199.9	7.670 -22.28	-1.230 -154.0
	.6757	-9.771 -341.1	25.48 -18.96	15.70 -.1250	-8.152 -184.6
5.703	.1679	-6.540 -238.5	15.61 -183.8	9.075 -62.43	-8.374 -184.8
	.3251	-20.07 -241.5	33.77 -147.6	13.69 -29.16	-8.282 -184.3
	.6767	-15.36 -34 .8	29.97 -29.46	14.60 -10.27	-8.186 -185.4
5.890	.1601	-4.926 -252.7	8.161 -176.8	3.234 -69.51	-8.106 -183.4
	.3339	-13.06 -227.7	24.65 -171.8	11.59 -39.59	-8.169 -185.9
	.6679	-22.53 -266.8	35.75 -114.9	13.22 -21.78	-8.172 -185.2

TABLE 4-13. POST-THERMAL-VACUUM FREQUENCY RESPONSE, TEST SPECIMEN NO. 2 (Continued)

JUL. 27, 1965 9:15 A.M. RUN 17220 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
6.109	.1679	-4.122 -254.7	4.565 -179.8	.4428 -74.58	-7.836 -185.4
	.3173	-8.875 -230.2	18.55 -179.3	9.682 -49.53	-8.309 -185.5
	.6884	-16.95 -222.8	28.95 -167.0	12.00 -29.90	-8.062 -185.5
6.289	.1787	-4.421 -252.0	2.156 -188.6	-2.264 -80.69	-7.893 -185.0
	.3203	-7.775 -239.9	15.26 -176.1	7.490 -56.6	-8.073 -186.5
6.320	.3320	-7.853 -234.0	15.96 -179.1	8.129 -53.21	-8.108 -185.8
6.468	.1708	-3.876 -254.6	.8837 -185.9	-2.993 -80.55	-8.027 -183.9
	.3261	-7.805 -238.4	15.73 -174.8	7.927 -53.34	-7.927 -184.7
	.6640	-12.55 -225.7	22.97 -171.5	10.42 -37.37	-8.098 -185.2
6.507	.1767	-4.484 -256.0	-.4965 -185.8	-4.981 -81.84	-7.735 -185.6
	.3242	-6.843 -242.6	12.22 -180.4	5.383 -63.09	-7.927 -185.3
	.6523	-9.672 -229.6	18.33 -175.9	8.662 -45.57	-8.049 -185.3
6.718	.1718	-4.322 -255.8	-2.525 -192.6	-6.848 -88.53	-8.211 -187.0
	.3359	-6.469 -243.9	10.46 -181.1	4.053 -65.17	-8.084 -186.7
	.6679	-8.716 -233.1	16.18 -177.9	7.466 -51.06	-7.974 -186.2
6.914	.1757	-4.599 -258.7	-3.481 -193.3	-8.081 -92.12	-7.958 -185.2
	.3271	-5.866 -248.0	7.709 -184.7	1.843 -72.75	-7.916 -185.7
	.6582	-7.823 -234.7	14.00 -179.4	6.181 -54.22	-7.922 -186.3
7.062	.1718	-4.161 -259.7	-6.597 -198.7	-10.75 -98.46	-8.173 -186.1
	.3359	-5.747 -249.0	6.884 -184.8	1.137 -73.89	-8.054 -187.1
	.6718	-7.270 -237.8	12.09 -180.3	4.820 -58.23	-7.983 -186.2
7.289	.1611	-4.526 -261.2	-10.88 -207.6	-15.40 -108.9	-7.863 -187.1
7.296	.3535	-5.901 -251.2	5.901 -181.8	.0000 -73.05	-7.972 -187.2
	.6650	-6.922 -239.6	10.40 -180.7	3.482 -60.35	-8.012 -186.7
7.492	.1669	-4.660 -260.0	-9.628 -198.3	-14.28 -98.40	-8.069 -188.3
7.476	.6777	-6.726 -241.7	8.979 -180.5	2.253 -62.31	-7.938 -187.2
7.703	.1679	-4.975 -260.4	-9.631 -192.1	-14.60 -92.63	-8.020 -188.5
	.3251	-5.788 -256.8	2.871 -184.0	-2.917 -80.94	-7.963 -187.5
	.6621	-6.481 -245.3	7.587 -181.1	1.105 -66.49	-8.017 -187.2
7.890	.1640	-4.566 -260.9	-13.55 -191.9	-18.06 -92.86	-8.183 -187.9
	.3417	-5.560 -257.0	.8959 -184.6	-4.664 -81.62	-8.052 -187.2
8.406	.1679	-5.434 -266.0	-18.44 -246.5	-23.88 -152.6	-8.120 -187.6
8.382	.1796	-5.472 -266.2	-12.97 -196.5	-18.44 -102.8	-8.016 -188.0
9.062	.3261	-6.098 -264.4	-5.967 -193.8	-12.06 -98.31	-8.139 -188.7
	.6562	-6.472 -258.6	1.337 -181.2	-5.134 -79.92	-8.010 -189.3
9.468	.1718	-6.020 -269.3	-38.89 -139.6	-44.91 -49.00	-8.056 -189.9
10.28	.1748	-6.468 -274.9	-32.56 -137.5	-39.03 -52.49	-8.198 -191.0
	.3271	-6.557 -267.4	-10.47 -194.8	-17.03 -102.2	-8.154 -190.9
	.6796	-7.330 -265.1	-3.955 -183.6	-11.28 -88.77	-8.056 -190.6
15.09	.1640	-9.968 -286.9	-34.48 -22.21	-44.45 -309.1	-8.513 -196.0
	.3330	-10.15 -283.2	-23.52 -212.5	-33.67 -135.8	-8.418 -197.0
	.6718	-9.905 -281.0	-34.72 -197.7	-44.63 -111.8	-8.338 -197.7
19.75	.1757	-12.13 -289.4	-26.84 -326.1	-38.98 -255.6	-8.989 -202.0
	.3339	-12.38 -296.3	-32.14 -50.11	-44.53 -346.4	-9.009 -202.2
	.6738	-12.77 -288.6	-34.32 -301.8	-47.09 -230.5	-8.831 -204.0

11:41 A.M.

TABLE 4-14. POST-RESISTANCE TO HEAT FLOW FREQUENCY RESPONSE, TEST SPECIMEN NO. 2

SEP. 9, 1965 3:19 P.M. RUN 17287 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./ 1	LOAD/PIST POS.	LOAD/ 1	1 / VSIG
.5024	.1748	.0488 -195.9	-6.517 -182.4	-6.468 -18.42	-3.440 -178.5
	.3203	.5136 -195.2	-5.970 -183.8	-5.456 -19.06	-3.626 -179.6
	.6660	.8496 -194.5	-5.462 -180.7	-4.612 -15.30	-3.531 -179.7
1.070	.1748	-.2963 -204.9	-3.933 -188.1	-4.229 -33.08	-3.538 -181.4
	.3271	.0253 -204.9	-4.860 -184.4	-4.834 -29.42	-3.582 -180.4
	.6455	.6445 -206.5	-5.073 -181.6	-4.428 -28.23	-3.568 -180.2
1.488	.1777	-.9042 -218.2	-3.708 -192.1	-4.612 -50.32	-3.491 -180.8
	.3339	-.3369 -216.6	-4.236 -185.2	-4.573 -41.86	-3.564 -180.5
	.6669	.2001 -215.3	-4.548 -181.4	-4.348 -36.81	-3.568 -180.4
1.980	.1582	-1.519 -226.8	-2.757 -192.1	-4.277 -58.95	-3.557 -181.9
	.3349	-.9350 -227.1	-3.536 -183.9	-4.471 -51.68	-3.428 -180.6
	.6660	-.2451 -225.5	-4.216 -183.5	-4.461 -49.09	-3.538 -180.7
2.484	.1572	-1.857 -237.9	-2.021 -185.7	-3.879 -63.73	-3.467 -180.9
	.3320	-1.412 -237.2	-3.025 -184.0	-4.438 -61.26	-3.521 -180.6
	.6669	-.7153 -235.3	-3.466 -183.0	-4.182 -58.33	-3.525 -181.1
3.468	.1728	-2.613 -259.8	.1962 -186.2	-2.416 -86.06	-3.505 -181.5
	.3242	-2.089 -258.9	-.8383 -183.6	-2.928 -82.66	-3.487 -181.4
	.6689	-1.595 -260.5	-1.730 -182.0	-3.326 -82.57	-3.493 -181.3
3.992	.1748	-3.259 -279.7	1.723 -183.6	-1.535 -103.3	-3.309 -181.6
	.3222	-2.693 -275.7	.9189 -184.3	-1.774 -100.1	-3.540 -182.4
	.6669	-2.321 -276.9	-.1513 -182.9	-2.473 -99.84	-3.547 -181.9
4.187	.1533	-3.660 -286.1	3.437 -191.4	-.2231 -117.5	-3.793 -181.5
	.3339	-3.186 -285.3	1.541 -184.3	-1.644 -109.6	-3.538 -182.5
	.6650	-2.722 -283.6	.4257 -183.9	-2.295 -107.6	-3.564 -181.6
4.359	.1757	-4.765 -298.4	3.850 -184.9	-.9155 -123.3	-3.392 -183.0
	.3251	-3.638 -296.1	2.071 -183.4	-1.567 -119.6	-3.391 -181.8
	.6728	-3.514 -292.6	1.232 -182.8	-2.281 -115.4	-3.488 -182.1
4.585	.1542	-5.804 -311.1	5.293 -194.2	-.5102 -145.3	-3.666 -180.5
	.3349	-4.729 -305.3	3.126 -184.7	-1.608 -130.0	-3.393 -181.8
	.6669	-4.272 -302.6	2.180 -183.1	-2.092 -125.8	-3.471 -182.2
4.804	.1728	-7.934 -321.8	7.165 -195.1	-.7690 -156.9	-3.667 -180.4
	.3242	-6.620 -317.0	4.383 -185.9	-1.636 -143.0	-3.381 -181.9
	.6591	-5.302 -312.2	3.345 -185.1	-1.956 -137.4	-3.574 -182.0
4.968	.1718	-11.84 -332.9	10.10 -203.3	-1.743 -176.3	-3.620 -180.6
	.3251	-8.721 -329.6	6.639 -186.5	-2.082 -156.2	-3.461 -182.6
	.6728	-7.266 -324.0	4.683 -185.5	-2.583 -149.5	-3.455 -182.2
5.164	.1582	-21.91 -320.8	17.80 -243.5	-4.104 -204.4	-3.377 -181.2
	.3310	-12.11 -337.7	9.541 -194.3	-2.575 -172.0	-3.615 -181.6
	.6728	-9.824 -333.5	6.624 -188.1	-3.199 -161.6	-3.437 -182.1
5.406	.1562	-20.00 -244.3	13.06 -337.4	-6.936 -221.8	-3.338 -183.6
	.3339	-17.23 -347.2	13.12 -198.6	-4.112 -185.8	-3.403 -182.5
	.6611	-13.01 -340.3	9.309 -193.5	-3.709 -173.9	-3.496 -181.7
5.578	.1728	-17.00 -242.5	8.818 -350.9	-8.182 -233.4	-3.273 -181.8
	.3232	-26.87 -324.8	21.29 -236.0	-5.584 -200.8	-3.408 -182.6
	.6757	-17.80 -345.9	12.98 -197.7	-4.814 -183.6	-3.508 -182.6
5.750	.1669	-33.06 -242.1	2.207 -354.0	-10.85 -236.1	-3.804 -182.2
	.3437	-25.35 -251.3	18.72 -320.4	-6.634 -211.8	-3.405 -182.1
	.6582	-26.18 -329.5	20.46 -225.2	-5.728 -194.8	-3.559 -182.3
5.945	.1708	-11.99 -249.9	-1.987 -356.2	-13.97 -246.2	-3.636 -181.2
	.3212	-18.74 -227.1	9.914 -352.9	-8.833 -226.1	-3.566 -183.0
	.6650	-26.82 -243.8	19.74 -316.8	-7.077 -205.7	-3.557 -182.1
6.179	.1699	-11.18 -253.2	-4.997 -355.5	-16.18 -243.8	-3.686 -181.4
	.3232	-15.58 -238.4	5.104 -353.5	-10.48 -231.9	-3.496 -181.7
	.6689	-21.73 -225.9	13.02 -346.3	-8.707 -212.3	-3.513 -182.8
6.367	.1728	-11.70 -257.9	-8.150 -13.62	-19.85 -271.5	-3.339 -183.4
	.3232	-14.54 -239.7	1.418 -358.0	-13.12 -237.8	-3.477 -183.2
	.6679	-18.30 -230.5	8.266 -350.6	-10.04 -221.2	-3.431 -182.5
6.570	.1738	-11.56 -256.0	-11.85 -13.12	-23.42 -269.2	-3.522 -183.8
	.3330	-13.12 -243.4	-1.652 -357.2	-14.78 -240.6	-3.605 -182.4
	.6611	-15.67 -235.8	3.904 -353.7	-11.77 -229.6	-3.474 -182.4

TABLE 4-14. POST-RESISTANCE TO HEAT FLOW FREQUENCY RESPONSE, TEST SPECIMEN NO. 2 (Continued)

SEP. 9, 1965 3:19 P.M. RUN 17287 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./ 1		LOAD/PIST POS.		LOAD/ 1		1 / VSIG	
6.812	.1748	-11.25	-262.6	-10.88	-8.300	-22.13	-270.9	-3.342	-181.9
	.3261	-12.74	-251.0	-3.081	-356.1	-15.82	-247.1	-3.452	-181.9
	.6708	-14.92	-235.5	1.548	-356.6	-13.37	-232.2	-3.513	-183.0
7.000	.1728	-10.97	-265.3	-13.97	-344.2	-24.95	-249.5	-3.538	-181.4
	.3222	-12.17	-254.2	-5.104	-354.6	-17.27	-248.8	-3.548	-181.9
	.6708	-14.04	-237.7	-.5258	-356.3	-14.56	-234.0	-3.543	-183.0
7.187	.1718	-11.46	-259.2	-21.39	-14.87	-32.86	-274.1	-3.652	-183.5
	.3203	-12.33	-254.9	-6.826	-4.562	-19.16	-259.4	-3.477	-183.5
	.6796	-13.72	-243.3	-2.044	-357.4	-15.76	-240.8	-3.447	-182.5
7.343	.1523	-11.39	-263.9	-32.46	-50.67	-43.86	-314.6	-3.667	-183.9
	.3378	-12.58	-256.6	-8.342	-2.359	-20.92	-258.9	-3.445	-183.4
	.6611	-13.06	-246.3	-4.151	-357.4	-17.21	-243.8	-3.560	-183.0
7.578	.1767	-11.35	-267.9	-18.24	-7.863	-29.59	-275.7	-3.474	-181.9
	.3291	-12.14	-258.0	-9.439	-.0507	-21.58	-258.1	-3.572	-183.3
	.6621	-12.73	-249.9	-5.376	-358.3	-18.11	-248.3	-3.470	-182.8
7.937	.1728	-12.29	-265.1	33.55	-61.64	21.26	-326.8	-3.603	-184.1
	.3232	-12.41	-261.0	-11.50	-5.835	-23.92	-266.9	-3.557	-183.7
	.6708	-13.07	-251.3	-6.860	-358.2	-19.93	-249.5	-3.535	-183.3
7.960	.1738	-11.94	-271.2	-21.02	-339.7	-32.96	-250.9	-3.391	-182.2
	.3212	-11.93	-263.6	-11.14	-359.6	-23.08	-263.2	-3.538	-182.5
	.6621	-12.46	-252.8	-7.745	-356.3	-20.20	-249.1	-3.557	-182.9
8.492	.1767	-12.28	-271.7	-26.84	-2.867	-39.13	-273.6	-3.474	-182.1
	.3330	-12.56	-268.4	-13.97	-9.27	-26.54	-277.5	-3.435	-183.5
	.6572	-12.67	-258.1	-10.42	-357.3	-23.09	-255.5	-3.552	-183.5
9.125	.1708	-12.62	-271.1	33.97	-163.3	21.36	-74.5	-3.669	-184.6
	.3242	-12.55	-271.7	-14.91	-8.800	-27.47	-280.5	-3.477	-182.8
	.6748	-12.94	-263.2	-12.44	-355.8	-25.38	-260.1	-3.479	-183.2
9.625	.1708	-13.03	-272.5	34.40	-227.3	21.36	-139.8	-3.733	-184.1
	.3164	-12.45	-272.3	-17.72	-356.3	-30.18	-269.3	-3.548	-183.2
	.6806	-13.07	-265.5	-14.50	-4.457	-27.57	-270.0	-3.514	-184.1
10.12	.1787	-12.99	-277.1	-32.25	-1.94	-45.24	-288.1	-3.475	-183.0
	.3310	-13.80	-272.9	-22.79	-8.105	-36.59	-281.0	-3.574	-184.5
	.6728	-13.49	-268.7	-16.37	-3.574	-29.87	-272.3	-3.496	-183.7
12.30	.1738	-15.13	-285.6	-29.82	-46.80	-44.95	-332.4	-3.439	-185.1
	.3203	-14.99	-281.3	-35.26	-235.8	-50.26	-157.2	-3.609	-185.2
	.6650	-14.74	-279.9	-21.86	-1.826	-36.61	-281.7	-3.508	-184.7
15.47	.1718	-16.90	-293.6	-21.93	-5.484	-38.84	-299.1	-3.471	-185.7
	.3193	-16.95	-29.0	-33.25	-74.56	-50.21	-4.582	-3.540	-186.5
	.6660	-16.85	-286.8	-33.71	-324.9	-50.56	-251.8	-3.560	-185.9
20.39	.1728	-20.20	-300.4	-18.58	-351.6	-38.79	-292.1	-3.587	-187.4
	.3164	-19.70	-298.8	35.85	-256.6	16.14	-205.5	-3.602	-188.0
	.6923	-19.59	-300.7	-27.72	-.2304	-47.32	-300.9	-3.559	-187.8

4:15 P.M.

TABLE 4-15. POST-ELECTROMAGNETIC INTERFERENCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

JUL. 12, 1965 9:55 A.M. RUN 17159 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1	LOAD/PIST POS.	LOAD/1	1/VSIG
.5058	.1611	5.105 -18.47	5.491 -197.6	10.59 -216.1	-.3100 -180.1
	.3154	5.747 -17.52	7.374 -9.382	13.12 -26.91	-.3173 -181.2
	.6572	6.180 -16.06	8.161 -3.734	14.34 -19.79	-.4272 -181.1
.9887	.1552	4.915 -33.68	9.614 -14.90	14.52 -48.59	-.6323 -180.0
	.3544	5.425 -27.70	8.789 -4.132	14.21 -31.83	-.5786 -182.4
	.6855	5.647 -28.14	8.601 -1.527	14.24 -29.67	-.4101 -182.0
1.472	.1582	3.837 -41.34	9.610 -13.26	13.44 -54.61	-.5200 -182.6
	.3115	4.651 -41.55	9.327 -7.527	13.97 -49.08	-.4770 -182.3
	.6562	5.371 -38.41	8.909 -2.992	14.28 -41.41	-.4770 -182.8
1.960	.1582	3.267 -53.13	11.65 -10.27	14.92 -63.41	-.5200 -184.1
	.3115	4.041 -50.75	10.31 -6.328	14.35 -57.07	-.5273 -183.5
	.6562	4.726 -48.50	9.519 -3.492	14.24 -51.99	-.4892 -183.6
2.457	.1582	2.539 -62.75	13.02 -10.10	15.56 -72.85	-.4697 -184.5
	.3134	3.404 -60.69	11.13 -5.136	14.53 -65.83	-.5004 -184.7
	.6611	4.160 -58.07	10.17 -3.738	14.33 -61.81	-.4980 -184.6
3.433	.1630	1.302 -83.37	15.62 -10.38	16.93 -93.75	-.5053 -187.1
	.3193	2.398 -80.40	13.63 -4.839	16.03 -85.24	-.4648 -186.9
	.6738	3.334 -78.40	12.02 -3.269	15.35 -81.67	-.5493 -186.4
3.960	.1562	1.118 -105.8	17.27 -5.957	18.39 -111.8	-.7285 -186.6
	.3105	1.794 -99.03	15.19 -4.636	16.98 -103.6	-.6567 -187.0
	.6611	2.316 -95.72	13.57 -3.316	15.89 -99.04	-.4492 -186.7
4.101	.1542	-.0561 -110.8	18.77 -11.66	18.72 -122.5	-.2158 -187.5
	.3408	1.399 -103.8	15.73 -5.527	17.13 -109.3	-.4843 -186.9
	.6845	2.249 -102.7	14.08 -3.710	16.33 -106.4	-.4589 -187.8
4.296	.1630	-.8740 -123.6	19.79 -10.28	18.92 -133.9	-.7944 -188.6
	.3193	.9545 -116.2	16.71 -5.597	17.67 -121.8	-.4648 -187.1
	.6796	1.594 -111.7	14.96 -3.500	16.56 -115.2	-.4394 -187.9
4.523	.1552	-3.359 -143.8	22.18 -11.18	18.82 -155.0	-.7836 -187.9
	.3388	-.5429 -123.7	17.98 -7.601	17.44 -131.3	-.3671 -189.2
	.6875	.6201 -120.0	15.97 -4.593	16.59 -124.6	-.5273 -187.9
4.718	.1640	-8.519 -157.3	26.23 -20.09	17.71 -177.4	-.1538 -188.7
	.3222	-2.239 -135.6	19.81 -8.218	17.57 -143.9	-.5112 -190.0
	.6767	-.3720 -129.2	17.23 -5.390	16.86 -134.6	-.5932 -188.7
4.968	.1611	-4.009 -78.65	4.419 -178.8	.4101 -257.5	-.7553 -190.7
	.3105	-4.566 -152.4	22.16 -9.097	17.59 -161.5	-.3466 -188.3
	.6484	-2.093 -139.9	18.81 -6.878	16.72 -146.8	-.4589 -189.2
5.125	.1591	-5.861 -64.56	14.79 -205.0	8.935 -269.6	-.3647 -191.8
	.3105	-9.461 -159.3	25.64 -20.82	16.18 -180.1	-.6811 -190.0
	.6503	-4.306 -152.0	20.71 -8.355	16.40 -160.3	-.6176 -189.3
5.312	.1572	-4.582 -81.77	-1.384 -218.2	-5.966 -300.0	-.2133 -189.3
	.3144	-18.56 -150.0	33.43 -48.95	14.87 -198.9	-.4965 -191.3
	.6562	-8.540 -160.7	24.06 -13.19	15.52 -173.9	-.4418 -190.2
5.539	.1601	-5.406 -102.9	-11.28 -176.3	-16.69 -279.2	-.0537 -190.8
	.3457	-24.95 -50.65	38.56 -159.8	13.60 -210.4	-.3125 -191.5
	.6806	-13.44 -173.1	28.09 -13.78	14.65 -186.9	-.4257 -190.2
5.742	.1572	-5.446 -86.55	-11.08 -189.1	-16.53 -275.6	-.3696 -188.7
	.3056	-10.54 -57.36	20.81 -176.1	10.27 -233.5	-.3525 -190.5
	.6972	-21.79 -140.0	35.22 -59.39	13.43 -199.4	-.6113 -190.7
5.898	.1562	-3.494 -90.02	-26.60 -158.5	-30.10 -248.5	-.6274 -188.7
	.3242	-8.388 -69.64	15.37 -173.7	6.988 -243.4	-.4599 -192.6
	.6679	-18.94 -59.82	30.81 -154.1	11.86 -213.9	-.5429 -192.0
6.117	.1591	-3.494 -89.41	-13.14 -337.1	-16.64 -66.59	-.9091 -192.5
	.3066	-5.965 -71.29	9.431 -184.7	3.465 -256.0	-.2988 -192.8
	.6855	-14.42 -56.28	24.52 -166.5	10.09 -222.8	-.5639 -190.6
6.304	.1562	-5.292 -96.11	-8.418 -147.1	-13.71 -243.3	-.3198 -189.1
	.3066	-5.078 -74.26	5.561 -187.8	.4833 -262.0	-.2709 -192.8
	.6748	-10.75 -61.58	19.22 -169.4	8.467 -231.0	-.5957 -191.1
6.500	.1601	-3.873 -93.89	1.721 -78.14	-2.151 -172.0	-.8090 -193.8
	.3193	-4.643 -82.82	1.384 -181.3	-3.259 -264.1	-.5917 -193.6
	.6738	-8.352 -63.37	14.34 -174.4	5.996 -237.7	-.5395 -192.9

TABLE 4-15. POST-ELECTROMAGNETIC INTERFERENCE FREQUENCY RESPONSE, TEST SPECIMEN NO. 3 (Continued)

JUL. 12, 1965 9:55 A.M. RUN 17159 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./1		LOAD/PIST POS.		LOAD/1		1/VSIG	
6.687	.1591	-4.689	-91.47	-3.706	-249.1	-8.395	-340.6	-.2622	-191.5
	.3212	-4.881	-83.72	.5405	-180.7	-4.340	-264.5	-.4379	-193.0
	.6679	-7.639	-66.74	12.20	-176.9	4.568	-243.7	-.6503	-193.0
6.929	.1601	-3.547	-88.42	-5.480	-108.4	-9.028	-196.8	-.6137	-190.5
	.3193	-4.157	-83.36	-1.970	-184.4	-6.127	-267.8	-.5673	-191.5
	.6738	-7.237	-69.89	10.12	-176.5	2.884	-246.4	-.6103	-193.8
7.109	.1601	-3.708	-93.46	-26.60	-303.6	-30.31	-37.12	-.3125	-191.2
	.3222	-4.841	-87.39	-2.422	-180.2	-7.264	-267.6	-.5844	-194.9
	.6816	-6.940	-73.63	8.029	-177.3	1.088	-250.9	-.4843	-193.7
7.273	.1611	-4.263	-93.98	-11.78	-245.8	-16.05	-339.8	-.8032	-195.7
	.3212	-4.788	-89.32	-4.780	-185.5	-9.568	-274.8	-.2597	-193.2
	.6748	-6.634	-75.87	6.260	-179.3	-.3735	-255.2	-.5014	-193.1
7.476	.1552	-7.250	-96.08	6.390	-165.9	-.8603	-262.0	-.8334	-192.9
	.3427	-5.776	-89.53	-4.765	-187.1	-10.54	-276.6	-.8041	-194.4
	.6552	-6.792	-78.98	4.836	-177.9	-1.956	-256.9	-.6381	-194.3
7.687	.1562	-5.494	-90.57	-1.441	-307.4	-6.936	-38.03	-.2133	-196.5
	.3134	-4.554	-92.14	-10.30	-182.6	-14.86	-274.8	-.7519	-195.0
	.6513	-6.311	-81.20	3.283	-178.4	-3.027	-259.6	-.6406	-194.3
7.882	.1542	-6.589	-87.39	-10.93	-315.0	-17.52	-42.40	-.5834	-198.1
	.3457	-6.927	-91.58	-6.526	-189.0	-13.45	-280.5	-.3149	-194.0
	.6435	-6.607	-81.48	2.448	-183.0	-4.158	-264.5	-.6127	-195.8
8.351	.1582	-9.392	-89.05	12.23	-266.9	2.854	-356.0	.0000	-195.7
	.3095	-6.020	-97.64	-19.89	-198.1	-25.91	-295.7	-.7871	-194.8
	.6796	-7.141	-84.40	-.2294	-184.6	-7.370	-269.0	-.5346	-196.0
8.867	.1562	-6.816	-97.72	-18.18	-264.2	-24.99	-1.984	-.1611	-198.7
	.3076	-5.856	-100.2	-26.02	-184.5	-31.87	-284.7	-.5615	-195.3
	.6787	-6.875	-90.01	-3.250	-181.6	-10.12	-271.6	-.7104	-196.0
9.468	.1582	-5.704	-98.23	4.860	-354.8	-.8432	-93.10	-.6210	-195.1
	.3154	-6.351	-99.94	-16.95	-213.1	-23.31	-313.0	-.8227	-196.9
	.6669	-6.948	-93.54	-6.423	-184.8	-13.37	-278.3	-.5551	-197.2
10.06	.1601	-7.335	-109.9	-27.35	-60.76	-34.75	-170.7	-.7602	-200.9
	.3173	-6.516	-98.23	-2.331	-349.9	-8.847	-88.15	-.5260	-197.1
	.6660	-7.509	-96.42	-9.947	-190.8	-17.45	-287.2	-.5566	-198.7
11.99	.1552	-8.410	-111.0	-.5991	-20.27	-9.009	-131.3	-1.033	-204.4
	.3369	-8.360	-109.1	-36.32	-280.1	-44.68	-29.35	-.6811	-203.5
	.6718	-8.742	-104.5	-18.41	-196.8	-27.15	-301.4	-.8115	-202.8
15.14	.1542	-13.28	-108.1	-4.607	-182.5	-17.89	-290.6	-.5883	-205.8
	.3378	-12.43	-120.1	-38.27	-160.3	-50.70	-280.4	-1.070	-207.5
	.6816	-11.54	-115.0	-29.68	-176.4	-41.22	-291.4	-.9399	-2 7.2
19.76	.1484	-18.91	-133.4	-18.58	-42.46	-37.50	-175.8	-1.340	-215.0
	.3271	-14.11	-133.4	-26.71	-56.46	-40.82	-189.9	-1.202	-217.3
	.6533	-14.35	-127.1	-29.96	-146.6	-44.32	-273.7	-1.252	-215.5

11:03 A.M.

TABLE 4-16. CONTAMINATION, DAILY LOG OF FLUID SAMPLES

DATE	SPECIMEN NO.			FLUID & CELL TEMP. (°F)				TYPE OF TEST					FREQUENCY RESPONSE RUN NO.	HYDRAULIC FLUID SAMPLES P = PRESSURE R = RETURN	REMARKS
								PRE FREQ. RESP.		FREQ. RESP.	POST FREQ. RESP.				
	2	3	4	+275	ROOM	0	-35	NULL	VEL.		NULL	VEL.			
20 NOV			X		X					X			16654	P-1, R-1 P-2, R-2	PRE FREQ. RESP. POST FREQ. RESP.
20 NOV		X			X					X			16655	P-3, R-3	POST FREQ. RESP.
21 NOV		X			X				X					P-4, R-4	PRE FREQ. RESP.
21 NOV		X		X						X		X	16659	P-5, R-5	POST FREQ. RESP.
21 NOV	X			X						X			16660	P-6, R-6	POST FREQ. RESP.
23 NOV														P-7, R-7	WATER IN OIL
1 DEC					X			X	X	X			16642	P-8, R-8 P-9, R-9	PRE FREQ. RESP. POST FREQ. RESP.
2 DEC	X				X			X	X	X			16709	P-10, R-10 P-11, R-11	NO ACTUATOR PRE FREQ. RESP.
2 DEC					X			X	X	X			16710	R-12 R-13	POST FREQ. RESP. PRE FREQ. RESP.
2 DEC														P-13	POST FREQ. RESP.
3 DEC														R-14	PRIOR TO NEW ACTUATOR
4 DEC					X					X			16712	P-15, R-15 P-16, R-16	PRE FREQ. RESP. POST FREQ. RESP.
7 DEC														P&R-17	NO ACTUATOR
9 DEC			X		X			X	X					P-18, R-18	POST RUN
10 DEC			X	X				X	X	X	X		16729	P-19, R-19	POST FREQ. RESP.
11 DEC		X			X			X	X					R-20	POST RUN
11 DEC		X		X				X	X						
11 DEC		X			X			X	X						
14 DEC					X			X	X					P-21, R-21	PRE RUN
14 DEC				X						X	X	X	16749	P-22, R-22	POST FREQ. RESP.
15 DEC														P&R-23	NO ACTUATOR
16 DEC					X			X	X						
22 DEC														P&R-29	NO ACTUATOR

TABLE 4-16. CONTAMINATION, DAILY LOG OF FLUID SAMPLES (Continued)

DATE	SPECIMEN NO.			FLUID & CELL TEMP. (°F)				TYPE OF TEST					FREQUENCY RESPONSE RUN NO.	HYDRAULIC FLUID SAMPLES P = PRESSURE R = RETURN	REMARKS
								PRE FREQ. RESP.		FREQ. RESP.	POST FREQ. RESP.				
	2	3	4	+275	ROOM	0	-35	NULL	VEL.		NULL	VEL.			
23 DEC		X			X			X	X	X			16825	P-30, R-30	POST FREQ. RESP.
4 JAN		X			X			X	X					P-31, R-31	POST RUN
5 JAN		X				X		X	X	X			16883	P-32, R-32	POST FREQ. RESP.
5 JAN		X					X	X	X	X			16884	P-33, R-33	POST FREQ. RESP.
6 JAN			X		X					X	X	X	16892	P&R-34	NO ACTUATOR
7 JAN			X			X		X	X	X			16904	P-35, R-35 P-36, R-36	PRE FREQ. RESP. POST FREQ. RESP.
8 JAN			X				X	X	X	X			16914	P-37, R-37	POST FREQ. RESP.

TABLE 4-17. CONTAMINATION, ANALYSIS OF FLUID SAMPLES

SAMPLE IDENT.	SAMPLE	DATE	NUMBER OF PARTICLES (SIZE - MICRONS)				
			10-25	26-50	51-100	100+	FIBERS
P-1	Before Run	20 Nov	478	153	18	7	3
R-1	Before Run	20 Nov	494	133	24	17	2
P-2	After Run	20 Nov	170	55	5	7	1
R-2	After Run	20 Nov	354	87	17	15	6
P-3		20 Nov	448	163	29	12	2
R-3		20 Nov	408	93	11	12	9
P-4		21 Nov	2,525	44	6	1	4
R-4		21 Nov	2,000	65	5	3	5
P-5	After High-Temp. Run	21 Nov	400	83	22	27	
R-5	After High-Temp. Run	21 Nov	205	61	4	6	
P-6	Before Run	21 Nov	1,049	90	64	36	
R-6	Before Run	21 Nov	395	63	47	15	
P-7	After High-Temp. Run	23 Nov	5,050	281	4	5	
R-7	After High-Temp. Run	23 Nov	7,550	103	17	10	
	Oil Changed (High-Water Content)						
P-8	Before Run	1 Dec	94	27	6	3	
R-8	Before Run	1 Dec	970	190	21	15	
P-9	After Run	1 Dec	187	56	10	6	
R-9	After Run	1 Dec	785	121	27	6	
P-10		2 Dec	207	103	8	5	
R-10		2 Dec	394	136	20	5	
P-11		2 Dec	640	163	11	7	
R-11		2 Dec	736	190	12	4	

TABLE 4-17. CONTAMINATION, ANALYSIS OF FLUID SAMPLES (Continued)

SAMPLE IDENT.	SAMPLE	DATE	NUMBER OF PARTICLES (SIZE - MICRONS)				
			10-25	26-50	51-100	100+	FIBERS
R-12		2 Dec	573	193	20	12	
R-13		2 Dec	570	187	29	12	
R-14		2 Dec	464	163	15	13	
P-13		3 Dec	582	166	12	3	6
P-15		3 Dec	370	82	7	6	4
R-15		3 Dec	676	145	16	4	
P-16		3 Dec	252	91	3	11	14
R-16		3 Dec	551	174	17	6	2
P&R-17		7 Dec	248	90	70	3	
P-18		9 Dec	536	128	17	14	3
R-18		9 Dec	388	126	11	6	1
P-19		10 Dec	352	107	13	15	2
R-19		10 Dec	137	42	1	5	
R-20		11 Dec	745	420	38	10	3
P-21		14 Dec	351	137	15	10	5
R-21		14 Dec	290	107	14	7	11
P-22		14 Dec	238	99	18	16	8
R-22		14 Dec	143	54	6	4	4
P&R-23		15 Dec	1,730	109	9	3	13
P&R-29		22 Dec	519	191	9	3	
P-30		23 Dec	302	73	6	8	3
R-30		23 Dec	649	232	36	10	6
P-31		4 Jan	627	100	6	7	7

TABLE 4-17. CONTAMINATION, ANALYSIS OF FLUID SAMPLES (CONTINUED)

SAMPLE IDENT.	SAMPLE	DATE	NUMBER OF PARTICLES (SIZE - MICRONS)				
			10-25	26-50	51-100	100+	FIBERS
R-31		4 Jan	353	100	12	5	4
P-32		5 Jan	6,000	1,600	43	6	3
R-32		5 Jan	2,525	354	15	14	
P-33		5 Jan	13,300	377	5	6	6
R-33		5 Jan	7,200	447	12	8	3
P&R-34		6 Jan	805	420	12	7	
P-35		7 Jan	521	117	8	3	1
R-35		7 Jan	326	312	15	0	4
P-36		7 Jan	958	88	2	1	3
R-36		7 Jan	3,430	191	23	10	
P-37		8 Jan	2,900	1,270	41	16	2
R-37		8 Jan	3,225	860	24	7	2
Viscosity		8 Jan		10.9 csks at +100°F			

TABLE 4-18. POST-HUMIDITY FREQUENCY RESPONSE, TEST SPECIMEN NO. 3

AUG. 4, 1965 1:31 P.M. RUN 17269 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./ 1	LOAD/PIST POS.	LOAD/ 1	1 / VSIG
.5075	.1748	6.259 -16.52	8.237 -11.08	14.49 -27.60	-3.824 -183.2
	.3193	6.794 -16.12	8.611 -5.980	15.40 -22.10	-3.960 -180.3
	.6542	7.334 -15.42	8.454 -2.417	15.78 -17.84	-3.416 -179.7
1.003	.1738	6.118 -30.70	9.477 -10.87	15.59 -41.57	-4.505 -174.4
	.3173	6.587 -27.89	9.255 -2.722	15.84 -30.61	-3.129 -185.1
	.6767	7.014 -27.66	8.907 -1.488	15.92 -29.15	-3.666 -178.0
1.492	.1767	5.347 -42.55	10.48 -8.250	15.83 -50.80	-3.790 -180.6
	.3281	5.955 -40.39	9.599 -6.707	15.55 -47.10	-3.658 -179.0
	.6533	6.487 -38.46	9.333 -2.300	15.82 -40.76	-3.731 -180.8
1.984	.1777	4.848 -52.36	11.19 -8.121	16.04 -60.48	-3.742 -180.3
	.3300	5.477 -49.13	10.30 -5.292	15.77 -54.42	-3.540 -180.6
	.6572	5.864 -48.69	9.814 -3.582	15.67 -52.27	-3.567 -180.5
2.488	.1748	4.221 -61.18	12.56 -7.585	16.79 -68.77	-3.635 -181.3
	.3271	5.075 -58.90	11.13 -4.773	16.20 -63.67	-3.633 -181.0
	.6738	5.468 -58.69	10.45 -3.082	15.92 -61.77	-3.597 -180.9
3.476	.1679	3.688 -84.53	14.64 -6.781	18.33 -91.32	-3.655 -181.3
	.3417	4.112 -81.53	13.21 -4.031	17.32 -85.57	-3.619 -181.2
	.6572	4.393 -81.49	12.36 -2.308	16.75 -83.80	-3.610 -181.4
4.015	.1015	2.827 -113.3	18.11 -8.960	20.94 -122.2	-4.956 -183.1
	.3447	3.431 -96.24	14.81 -4.164	18.24 -100.4	-3.348 -182.9
	.6572	3.610 -97.58	13.79 -2.863	17.40 -100.4	-3.763 -181.1
4.179	.1689	2.770 -112.3	17.30 -6.539	20.07 -118.8	-4.336 -182.0
	.3466	3.213 -108.3	15.57 -4.156	18.79 -112.5	-3.912 -179.7
	.6835	3.205 -104.6	14.54 -3.304	17.74 -107.9	-3.601 -182.6
4.367	.1669	1.229 -125.2	18.78 -7.492	20.01 -132.7	-3.935 -177.7
	.3457	2.349 -113.7	16.48 -5.203	18.83 -118.9	-3.305 -183.0
	.6542	2.691 -112.9	15.36 -3.703	18.05 -116.6	-3.671 -180.9
4.609	.1757	-.1953 -133.1	20.14 -11.89	19.94 -145.0	-3.553 -186.2
	.3291	1.333 -125.9	17.91 -6.082	19.25 -131.9	-3.338 -183.0
	.6523	1.992 -124.2	16.35 -4.050	18.34 -128.2	-3.748 -180.6
4.835	.1748	-3.768 -150.0	22.96 -14.94	19.19 -165.0	-3.107 -182.0
	.3203	-.2963 -136.5	19.38 -7.851	19.09 -144.4	-3.450 -183.3
	.6591	.6933 -131.1	17.51 -5.753	18.20 -136.9	-3.504 -183.0
4.960	.1650	-8.035 -163.8	26.60 -24.99	18.56 -188.8	-4.385 -182.5
	.3378	-2.583 -152.5	21.37 -8.289	18.78 -160.8	-3.736 -179.5
	.6660				
5.000	.6582	-1.262 -144.8	19.31 -6.992	18.04 -151.8	-3.610 -181.0
5.203	.1708	-14.23 -92.51	30.00 -127.6	15.77 -220.1	-4.019 -180.0
	.3300	-7.114 -161.3	25.01 -15.21	17.90 -176.5	-3.313 -183.4
	.6572	-3.877 -153.3	21.46 -9.781	17.58 -163.1	-3.504 -182.4
5.421	.1669	-5.870 -74.35	14.96 -172.9	9.090 -247.3	-4.251 -181.4
	.3476	-13.07 -163.6	29.78 -28.13	16.70 -191.8	-3.455 -182.5
	.6513	-7.043 -162.1	24.07 -14.28	17.02 -176.4	-3.737 -182.8
5.578	.1728	-3.375 -76.71	5.024 -192.3	1.648 -269.0	-3.239 -181.2
	.3125	-17.43 -87.59	32.21 -125.4	14.78 -213.0	-3.807 -183.2
	.6757	-13.09 -167.2	28.95 -23.08	15.85 -190.3	-3.592 -181.3
5.765	.1679	-3.572 -83.59	.5893 -191.7	-2.983 -275.3	-3.981 -180.0
	.3339	-11.89 -64.58	25.00 -158.3	13.11 -222.9	-3.789 -184.1
	.6806	-21.28 -129.4	35.80 -73.22	14.51 -202.6	-3.513 -181.6
6.023	.1748	-2.845 -83.46	-5.186 -198.3	-8.032 -281.8	-3.635 -184.8
	.3242	-7.625 -65.80	17.75 -171.9	10.13 -237.7	-3.846 -181.8
	.6787	-15.46 -60.65	28.47 -152.6	13.01 -213.3	-3.663 -183.3
6.195	.1757	-2.894 -84.04	-8.769 -217.5	-11.66 -301.6	-3.359 -185.1
	.3281	-5.917 -68.80	13.23 -176.4	7.315 -245.2	-3.591 -183.5
	.6552	-11.32 -56.20	22.73 -167.2	11.41 -223.4	-3.726 -183.0
6.343	.1708	-3.423 -86.24	-9.841 -209.2	-13.26 -295.5	-3.269 -180.6
	.3164	-5.652 -74.99	10.66 -177.6	5.013 -252.6	-3.854 -182.2
	.6835	-9.212 -56.64	18.88 -171.8	9.672 -228.5	-3.559 -182.9
6.625	.1679	-3.572 -88.51	-12.83 -196.0	-16.41 -284.5	-3.721 -180.5
	.3398	-5.186 -74.73	8.479 -183.3	3.291 -258.0	-3.528 -181.1
	.6611	-8.002 -61.39	15.62 -175.3	7.623 -236.7	-3.675 -182.2
6.859	.1728	-3.897 -91.93	-20.23 -218.6	-24.13 -310.6	-3.667 -179.9
	.3271	-4.992 -80.64	4.511 -186.4	-.4809 -267.0	-3.676 -181.8
	.6816	-6.940 -64.89	12.78 -177.7	5.844 -242.6	-3.521 -182.8

TABLE 4-18. POST-HUMIDITY FREQUENCY RESPONSE, TEST SPECIMEN NO. 3
(Continued)

AUG. 4, 1965 1:31 P.M. RUN 17269 FREQUENCY RESPONSE TEST

FREQ.	AMPL. VOLTS (P-P)	PISTON POS./ 1		LOAD/PIST POS.		LOAD/ 1		1 / VSIG	
6.934	.1660	-3.171	-93.88	-31.89	-23.33	-35.06	-117.2	-3.724	-185.3
	.3388	-4.675	-80.18	3.804	-188.0	-.8701	-268.2	-3.571	-182.0
	.6630	-6.700	-68.34	11.08	-178.1	4.388	-246.4	-3.686	-182.5
7.218	.1669	-3.522	-94.44	-41.13	-22.54	-44.66	-116.9	-3.672	-184.7
	.3437	-4.628	-80.06	2.187	-198.8	-2.441	-278.9	-3.513	-183.2
	.6621	-6.254	-71.57	8.903	-179.4	2.648	-251.0	-3.699	-182.6
7.390	.1679	-4.710	-90.61	-17.72	-221.4	-22.43	-312.0	-3.787	-181.5
	.3437	-5.149	-83.37	.8520	-190.0	-4.297	-273.4	-3.725	-182.1
	.6630	-6.058	-72.49	7.209	-181.4	1.150	-253.9	-3.679	-182.6
7.593	.1757	-4.278	-91.57	-20.82	-265.5	-25.10	-357.0	-3.649	-185.0
	.3232	-3.957	-87.98	-3.991	-189.6	-7.958	-277.6	-3.764	-182.9
	.6738	-5.696	-77.10	5.710	-181.4	.0131	-258.5	-3.540	-183.1
7.789	.1757	-4.848	-97.17	-24.69	-130.3	-29.54	-227.5	-3.457	-181.8
	.3300	-4.751	-88.57	-5.132	-195.6	-9.885	-284.2	-3.631	-184.0
	.6572	-5.578	-81.29	3.992	-180.5	-1.585	-261.8	-3.645	-182.8
7.984	.1699	-4.554	-96.03	-34.23	-248.1	-38.79	-344.1	-3.421	-183.1
	.3173	-4.634	-90.38	-6.491	-192.7	-11.12	-283.1	-3.593	-184.1
	.6806	-5.688	-81.01	3.118	-181.7	-2.569	-262.7	-3.567	-182.9
8.500	.1738	-5.095	-103.8	-25.93	-62.37	-31.02	-166.2	-3.684	-182.2
	.3291	-5.373	-94.60	-9.166	-189.8	-14.53	-284.4	-3.538	-182.3
	.6494	-5.723	-85.74	.1499	-185.2	-5.573	-270.9	-3.543	-183.4
9.000	.1748	-5.876	-97.82	-22.27	-243.5	-28.15	-341.3	-3.602	-184.9
	.3222	-4.814	-95.73	-16.58	-216.4	-21.40	-312.1	-3.774	-183.6
	.6796	-6.120	-89.43	-2.175	-189.6	-8.295	-279.0	-3.613	-183.8
9.593	.1669	-5.197	-103.1	-25.48	-39.71	-30.68	-142.8	-3.605	-184.8
	.3447	-5.729	-98.19	-19.17	-227.0	-24.90	-325.2	-3.521	-183.5
	.6669	-6.709	-93.36	-4.158	-188.0	-10.84	-281.4	-3.698	-183.6
10.31	.1699	-6.749	-106.3	-28.52	-189.0	-35.26	-295.4	-3.815	-183.8
	.3144	-6.211	-101.0	-28.35	-253.2	-34.56	-4.246	-3.620	-183.5
	.6787	-6.644	-97.29	-7.487	-190.3	-14.13	-287.6	-3.671	-184.1
12.18	.1699	-8.238	-107.9	-22.54	-305.0	-30.78	-52.97	-3.572	-184.2
	.3222	-7.583	-108.1	-24.67	-327.8	-32.25	-76.07	-3.555	-184.7
	.6542	-8.003	-106.9	-20.50	-178.7	-28.51	-285.7	-3.696	-185.0
15.36	.1650	-10.02	-122.4	-28.46	-43.64	-38.48	-166.1	-3.726	-187.1
	100265.								
15.42	.3408	-10.11	-117.4	-19.08	-230.9	-29.19	-348.3	-3.719	-185.7
	.6455	-9.595	-114.6	-46.72	-151.2	-56.32	-265.9	-3.684	-186.4
20.00	.1708	-13.87	-127.0	-24.85	-349.9	-38.74	-117.0	-3.638	-188.9
	.3212	-12.82	-126.8	-37.38	-284.8	-50.21	-51.70	-3.691	-183.5
	.6699	-12.77	-126.8	-43.80	-168.4	-56.58	-295.3	-3.679	-187.5

2:33 P.M.

TABLE 4-19. ACTUATOR FINAL ACCEPTANCE TEST RECORD, TEST SPECIMEN NO. 4

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1	Inspection	See Spec. 1A88230	Inspected
2.1.1	As-Received Cleanliness (Particles)	Size (Microns) / Number Return / Supply 10-25: 2,150 / 1,340 26-50: 530 / 210 51-100: 60 / 28 101+: 10 / 3	Not Recorded
2.1.2	Proof Pressure	No Damage	No Damage
2.1.3	Electrical and Mechanical Centering	±0.001325 (+24 v excitation at zero psig) ±0.006325 (+24 v excitation at 3,650 psig) ±0.00985 (+24 v excitation voltage) Allowable: 31.7 mv	Pins / Zero Psig / 3,650 Psig B & D: +10 mv / +18 mv F & H: +40 mv / +51 mv
2.1.4	Length, Adjustment, and Stroke	Actuator Centered 23.00±0.063 Actuator Retracted -1.45±0.030 Total Piston Stroke +2.90±0.032	Actuator Centered +0.024 Actuator Retracted +1.438 Total Piston Stroke +2.886
2.1.5	Feedback Potentiometer Continuity, Linearity, and Travel	See figure 8.	Continuity: Acceptable Extend: ABCD = 0.456, EFGH = 0.453 Retract: ABCD = 0.460, EFGH = 0.458
2.1.6	Coil Resistance	100±5 ohms at 100°F	98 ohm

TABLE 4-19. ACTUATOR FINAL ACCEPTANCE TEST RECORD, TEST SPECIMEN NO. 4 (CONTINUED)

PARA-GRAPH	TEST	ALLOWABLE	MEASURED
2.1.7	Dielectric Breakdown	No breakdown at 1,000 vdc for 60 seconds	No breakdown
2.1.8	Potentiometer Resistance	Pins — Ohms A & C 2,000±200 G & E 2,000±200 B & D 450 min., 700 max. F & H 450 min., 700 max.	Ohms 1,974 1,873 531 524
2.1.9	Servovalve Polarity	A+, B- : Retract B+, A- : Extend	A+, B- : Retracted B+, A- : Extended
2.1.10	Flow	10.5±1.5 gpm at 100°F	11.7 gpm
2.1.11	Internal Leakage	0.2 gpm min. 0.4 gpm max.	0.35 gpm
2.1.12	Static Seal Leakage	No external leakage	None
2.1.13	Piston Rod End Dynamic Seal Leakage	4 drops max.	None
2.1.14	Piston Packing Friction	100 psid	19 psid
2.1.15	Actuator Gain	0.031±0.0016 in./ma	Extend: 0.0335 Retract: 0.0319
2.1.16	Flow Gain	5.25 cis/ma ±10% (from 1.227 to 1.499 gpm per ma at 100°F)	1.22 gpm/ma
2.1.17	Frequency Response	Max. Amplitude Ratio: 3.5 db Max. Phase Lag: 35° at 1 cps	Plotted: see chart 3-22

APPENDIX 5

5. BIBLIOGRAPHY

5.1 Douglas

SM-41412	Saturn IB/V, S-IVB Test Plan
1A66248	Specification Control Drawing, Hydraulic Actuator Assembly
1A88230	Test Requirements, Hydraulic Actuator Assembly
1T01083	Test Control Drawing, Hydraulic Actuator Assembly
DSV-4B Design Memo 110A	Vibration, Acoustic, and Shock Test Criteria and Procedures for DE/Q Program
TM-DSV4B-MS-R5176	Note: This number was drawn from the EL & S Library to cross-reference this document (SM-46580) into the EL & S numbering system, thus enabling supplementary test reports to be assigned dash numbers.
TM-DSV4B-SSL-D-5176-1	Flight Control Hydraulic Actuator Assembly Thermo/Vacuum Qualification Test (M-4)
TM-DSV4B-EMV-R5176-2	High-Temperature Loaded Vibration Test of the Hydraulic Actuator Assembly
TM-DSV4B-ME-4914	Hydraulic Actuator Assembly Vibration Tests
TM-DSV4B-EE-R5223	EMC Test of a DSV4B Hydraulic Actuator, P/N 1A66248-503, S/N 9
TM-A-860-K410-553	Actuator Structural Compliance Test

5.2 Government

MSFC-PROC-166A	Procedure for Cleaning, Testing, and Handling of Space Vehicle Hydraulic System Components and Hydraulic Fluids
MIL-E-5272C	Specification for Environmental Testing, Aeronautical and Associated Equipment

5.3 Vendor

010-29937	Moog Drawing: Servoactuator Assembly, Model 17-189A
MR-828	Moog Model 010-42826 Servoactuator, Acceptance Test Procedure
MR-1009, Volume I	Moog Model 17-189, S-IVB, Development Test Report
Volume II	Moog Model 16-142, S-IVB Servovalve, Development Test Report
Volume III	Moog P/N 062-29867, S-IVB Potentiometer, Development Test Report